COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF AGRICULTURE

BULLETIN No. 257

SOILS OF PENNSYLVANIA

BY

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A Statement of the Origin and Capacity of the Soils of Various Counties, including a Discussion of the same by Townships, of the Counties East of the Allegheny Mountains, together, with Suggestions of their Adaptation to the Different Crops Grown

PART TWO

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VIRTUE
LIBERTY AND
INDEPENDENCE

PREFACE

Every business man needs to have as full and accurate knowledge of his assets as is possible. To carry on his business without such knowledge would be hazardous. The wise King of Israel declares, "The prudent man looketh well to his going;" hence we note the care with which men possessing the true business instinct make their regular accounting of stock.

The farmer's principal asset is his soil, and it is for the purpose of turning his thought in this direction and to encourage a more careful study of the subject, that this report upon the Soils of Pennsylvania has been prepared.

The Soil Survey, recently taken up by the Federal Government, has the approval of the general public, and its reports are receiving the attention of intelligent farmers and students of Agriculture in all sections of the country; but to cover the whole country within a reasonable time is a work of such magnitude that the survey made of the soils of any particular state is necessarily limited. It was thought, therefore, that having so great a variety of soil formations in Pennsylvania, containing so widely different characteristics, it would be well to have a closer survey made, and the report being too voluminous to be contained in one volume, has been divided into two parts, and the respective counties so grouped that Part I will be suited to one section of the State and Part II to the other.

Secretary of Agriculture.

LETTER OF TRANSMITTAL

York, Pa., March 16, 1914.

Hon. N. B. Critchfield, Secretary of Agriculture, Harrisburg, Pa.

Dear Sir:

I herewith transmit to you the manuscript of the bulletin on the soils of Pennsylvania, their origin, capacity and adaptation, together with a discussion of origin of soils and the climatic conditions prevailing throughout the State. I would suggest that this bulletin be divided into two parts, Part One, including all the counties east of the Allegheny Mountains, and Part Two, all the counties west of these mountains. This is a natural division, the former embracing all the areas of the Lower and Upper Silurian and Devonian ages with the exception of small areas, such as the Broad Top region in Huntingdon, Bedford and Fulton counties, the Anthracite region in Dauphin, Schuylkill, Northumberland, Carbon, Luzerne and Lackawanna counties, and small patches in Sullivan, Bradford, Tioga, Clinton and Potter counties, where the mountain flattens and small patches of the Carboniferous Age remains, while west of the Allegheny Mountains all the counties belong to this latter age.

I would further suggest that Part One include the following counties: Philadelphia, Delaware, Chester, Lancaster, York, Adams, Franklin, Cumberland, Dauphin, Lebanon, Berks, Lehigh, Montgomery, Bucks, Northampton, Fulton, Bedford, Blair, Huntingdon, Center, Clinton, Lycoming, Mifflin, Juniata, Snyder, Union, Perry, Northumberland, Montour, Columbia, Schuylkill, Carbon, Monroe, Pike, Luzerne, Wyoming, Lackawanna, Wayne, Susquehanna, Sullivan, Bradford and Tioga.

Part Two: Potter, McKean, Warren, Erie, Cameron, Elk, Forest, Venango, Crawford, Mercer, Clearfield, Jefferson, Clarion, Cambria, Indiana, Armstrong, Butler, Lawrence, Beaver, Allegheny, Somerset, Westmoreland, Fayette, Washington and Greene.

Yours very truly,

FRANKLIN MENGES.

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FOREWORD

The purpose of the bulletin is to bring to the farmers, a plain and simple statement of the soils of the various counties and townships, as well as localities in townships throughout the State, giving the origin, capacity and adaptation of the soils of the various sections. No effort is made at scientific discussions, and all terms with which the average farmer is not familiar, in so far as possible, have been eliminated and plain, simple statements to convey the ideas intended have been used. The natural methods of soil improvement have been advocated, that of having a growing plant on the land at all times, and in so far as possible, a soil improving plant instead of a soil exhausting one. These crops have been advocated in numerous sections in which they have never been raised; but from the examination of the soil and the prevailing climatic conditions, the author is convinced, after the soils have been improved by raising and plowing down, or better still feeding the less exacting leguminous crops such as sweet clover, or the cowhorn turnip and other less exacting varieties of the root crops, and rye among the cereal grains, and applying the manure, the land will produce the more exacting fall and spring sown, long and short season legumes as well as the more exacting root and cereal crops.

The livestock industry, with all its accessories, dairying, the production of beef, lamb, mutton and wool, but especially pork, wherever soil, climatic and market conditions justify such undertakings together with the arrangements of rotations for raising both the leguminous and cereal crops for feeding the animals to yield the largest returns as well as for producing the largest quantity of manure and other roughage to be returned to the soil, to maintain and increase its fertility, are advocated. That there are soil and climatic conditions under which crops are produced, especially suited for certain phases of the livestock industry, is well illustrated in the southwestern and western sections of the State where the Blue grass pasture will produce a superior grade of wool and more vigorous, stronger boned horses than in any other section of the State. Such soil and climatic conditions should be utilized wherever possible. Little is said about the uses of artificial fertilizer and lime because the Department has issued several bulletins on the uses of these materials to which the reader is referred.

It might be added, that wherever the methods here advocated that of having a growing crop on the soils at all times and using the manure as it is made or improving it by storage and plowing down

heavy sods, and after the farmer has learned how to produce and maintain a congenial environment for nitro-gathering bacteria in the soil and how to control toxic substances or conditions in the soil; artificial fertilizer or soil improving substances will be used as correctives and not promiscuously as they now are without a definite knowledge of what they accomplish in the soil. It must be understood that all discussions are necessarily general and limited because a detailed discussion would be inconveniently voluminous. The geological data were taken from the reports and maps of the Second Geological Survey of Penna. by Dr. J. P. Lesley in so far as these were accessible, and personal examinations of all the soil areas of the State were made by the author. Hon. Geo. S. Bliss, Director of the Weather Bureau, Philadelphia, prepared the charts and maps giving the normal annual precipitation throughout the various sections of the state for twenty-three years, the dates of the first killing frosts in fall and the last in the spring, the spring, summer, fall, winter and annual mean temperatures, which is probably one of the best pieces of work done for the agriculture of the State in years and for which the author hereby publicly expresses his thanks. His thanks are also due to the U. S. Geological Survey, the Bureau of Soils of the U. S. Dept. of Agriculture, for the soil survey of the State as far as they were available, and to Mr. W. H. Stout of Pinegrove, Schuylkill county, for valuable suggestions and assistance in a number of counties, as well as to many others all of which he hereby acknowledges. The historical data were taken from William Egle's History of the Commonwealth of Pennsylvania, and the Census data from the 13th Census of the United States.

FRANKLIN MENGES.

ORIGIN OF SOILS

The soils of Pennsylvania will be discussed in these pages, not as the inert remains of disintegrated rock and previous vegetation, but as an accumulation of these materials in which the process of formation, alteration, transportation, solution, deposition, oxidation, reduction, chemical interaction, fermentation, digestion or decay, such as takes place in the animals and plants producing similar compounds in the organic matter of the soils as are produced by these processes in plant and animal life are still going on and always will be.

This soil is the medium by which the farmer, through the capacity of the leaves of the plants, catches the sunlight or the energy, as Dr. Armsby says, which operates the bodily mechanism, and upon the regularity and sufficiency of which the energy supply for all human endeavor absolutely depends. The construction of the soil was brought about by the energy of the sun. The first soil was the solid rock which was disintegrated through agencies that likely do not now exist as they then did, but the soils of the present day that have been and are being formed come into existence through the energy of the sun. The sun rays strike the solid rock like innumerable little hammers and cause the rock to become heated, and the heat causes expansion amounting to at least (*1) an inch in each 100 feet of diameter during the variations of temperature such as occur in this State. This expansion and contraction caused by the rising and falling of temperatures has been great enough to cause the chipping of the rocks of hills and mountains and breaking these down; and where this has not been the case it has caused the formation of little cracks and crevices to afford a starting point for other agencies of disintegration, such as water, to break down the rocks. The rays of the sun when they fall upon water, warm the water as they do the rock, but unlike the rock the water changes into a gas or vapor, which, on account of it being lighter than the air about it, rises until it reaches such an altitude and such conditions that the particles of vapor again combine and form larger and larger particles or drops of water, and these fall in rain either upon the rock or on the sea and ocean, and if on the rock the rock absorbs a certain amount of the water, depending upon its structure and character. Granite rock may take up about 0.4% of its weight, marble 0.3%, lime stone 0.5% to 5.0%, chalk 20%, and sand stone variable amounts up to 10% or 12%. When this water becomes heated in the rock from the pelting of the sun's rays it expands in a similar way, as if it were heated in the boiler of a steam engine, and we well know what power such expansion exerts.

*Prof. N. H. Shaler.

But water has another capacity, that of expanding when it freezes and for this reason ice floats; were it not for the expansion of water upon freezing, our streams would freeze in all directions, and the summers would not be long enough to thaw them. A cubic foot of water when it freezes increases to 1.0908 cubic foot or it increases approximately one inch in size. Any rock or soil containing a cubic foot of water will when the water freezes be forced to expand to the same extent as would the cubic foot of water were it freezing without the rock. This expansive force of water when it passes from the liquid into the solid state is equal to a pressure of about 150 tons of ice to the square foot. After the rock has absorbed all the water it can hold the remainder flows over the surface whether horizontal or inclined, and if any of the rock has been disintegrated the water carries at least part with it, and this causes sedimentary accumulations until these become so vast and heavy that the pressure is sufficient to harden this sediment into rock, and sedimentary rock is formed out of the materials of which the original rock was made.

Flowing water is the great agency by which the materials are carried and laid down and sedimentary rock is formed, as already indicated. This water, brought by the sun in contact with the rock, does not only act by expansion and contraction in breaking up the rocks, and as a transporting agency, but it acts chemically, first, as a solvent of the rock, second, through the oxygen it dissolves out of the air, and brings both this and the oxygen chemically held in water into the closest contact with the rock materials. A good illustration of the greater activity of oxygen when dissolved in water or when acting through water as a solvent, is furnished when a highly polished iron implement such as a saw is allowed to lie in the rain and become wet by rain water it will rust quickly; whereas, the same implement could be allowed to be in contact with dry oxygen for a considerable time without any effects being noticeable. Third, as a deoxidising agent by taking oxygen away from the rock. Fourth, it acts as a hydrating agent by the water combining with some of the minerals of which the rock is composed, and forming so called hydrates.

The first of these as already indicated is solution. That the everlasting rocks are slowly going into solution or are being dissolved by water is evident from the amount of crust or solid materials that accumulate in vessels continuously used for heating water, and water, too, in which not a particle of solid matter could be seen even by the use of a microscope. This is true of water from wells and springs or water taken from streams and entirely clarified. Another thing, the mineral elements and minerals dissolved in the water are the same as those of which the rock over and through which the water flows are composed. It has been estimated from the

quantity of lime held in solution by water in the limestone regions of the Appalachian system, that 275 tons of limestone is dissolved annually in every square mile of such limestone formation. Similar estimates have been made for other minerals, such as magnesia, silica, etc. The water does not only take these minerals into solution, but it acts chemically on them or changes their composition so that they are more readily soluble.

The agencies by means of which these chemical changes are brought about are the gases held in solution by water, such as carbonic acid and oxygen, nitrogen and small quantities of the oxides of nitrogen. The effects of carbonic acid gas on limestone can readily be demonstrated by blowing the gases from the lungs through a piece of any kind of tubing into a glass of clear lime water. If the lime water is clear it will become cloudy or milky at first, but after continuous blowing for several minutes the lime water will become clear, whether clear at first or not, showing that something in the gases from the lungs has acted on the solid or the limestone formed in the limewater, by the gases from the lungs, and has put it into solution. This gas is carbonic acid, also known as Carbon dioxide. This gas does not act on limestone only, but on well nigh all even the most resistant minerals and is more effective when dissolved in water, than when in the gaseous conditions.

Carbon dioxide is not the only gas brought by water in contact with and into the rock, but oxygen, another of the gases of the air, is also dissolved in rain water and carried by it into the rock, and because of its being brought into such close proximity to the constituents of the rock, it acts more readily as well as more efficiently in changing the minerals of which the rock is made up by combining with these (No. 2). In this way the red ochreous soils in the micaceous shist formation in southeastern Pennsylvania were produced and are being produced now when the shistose rocks are decomposed. By the oxygen combining with the minerals of which the rock is composed, unless the substance so formed is carried away by solution, increase the bulk of the rock and in this way causes a strain that helps to disintegrate it. This action goes on to a far greater extent than investigators have been giving it credit.

Deoxidation or the taking away of oxygen as the rock is disintegrated, likely takes place in the Carbonaceous shales and where rock is decomposed under water. Hydration usually takes place at the same time as oxidation, in fact, it seems that the two are inseparable, in igneous rock disintegration, by water carrying oxygen in solution. After this combination of water with the minerals of the rock has begun, it seems to become contageous and vast sections of rock are disintegrated to a depth of many feet; whereas, other places in the same territory with the same rock little or no disintegration has

taken place. This kind of disintegration has been going on in the Syenite rock in the vicinity of Gettysburg, on parts of the Battlefield, where the very form of the original rock can still be seen, but has become so completely disintegrated that the residuum can be spaded with an ordinary shovel. Another place where this disintegration of Syenitic rock by hydration has taken place but has not proceeded to a complete unlocking of all cohesion occurs on the Harrisburg road about five miles north of Gettysburg. Here, boulders covered with disintegrated rock, retain their shape and when first exposed seem comparatively hard, but when struck with a hammer, instead of a clear ringing sound, give only a dull thud; and when exposed to the action of the atmosphere, especially freezing temperatures, soon fall to pieces showing that these stones had become rotten. The same thing has taken place in the Potsdam sand formation on Shunk's Hill, south of York and at Newman's sand quarry, east of York, near the N. C. R. R. Here the formation remains stratified and the rock apparently hard but when exposed soon, like the Syenite, swells slightly and changes into a gritty sand.

During the process of hydration, though taking place at an exceeding slow rate, the rock expands, which, after hydration has gone on to a sufficient extent, causes the disintegration of the rock, as was the case with the Syenite and the Potsdam sand. That hydration exerts a tremendous force is evident in bricks made of limestone clay in which small pieces of undecomposed limestone get into the bricks which when these are burned, the carbonate of lime is changed into the oxide of lime, and when the brick absorbs water, the lime becomes hydrated and expands with sufficient force to cause the hardest bricks to scale off or break. Water slacking lime is a process of hydration, and all farmers who have slacked lime know that some limes during the process of slacking increase to well nigh twice their original bulk. Whatever may be regarded by investigators to be the most potent agency of disintegration, it appears that hydration is the most desirable because, according to what has been said before, these stones or rock retain their original structure, though disintegrated, and with that structure they also retain approximately all components and the desirable elements of fertility, according to the following three analyses: The first, that of a fresh gray granite, second, a moderately firm but partially disintegrated rock but retaining its granitic appearance, and, third, the rock completely disintegrated but in position where this process took place.

Constituents	I	II	III
	%	%	%
Silica $Si\ O_2$	69.33	66.82	65.69
Titanium, ...	not det.	not det.	0.31
Alumina, ...	14.33	15.62	15.23

Iron protoxide,	3.61	1.69	.....
Iron sesque oxide,	.....	1.88	4.39
Lime,	3.21	3.13	2.63
Magnesia,	2.44	2.76	2.64
Soda,	2.70	2.58	2.12
Potash,	2.67	2.04	2.00
Phosphoric acid,	0.10	not det.	0.06
Lost on heating,	1.22	3.27	4.70
Total,	99.60	99.79	99.77

A glance at these figues will show that there is a suprising small difference in the composition of the original granite, the partially and the completely disintegrated rock. There is a slight decrease of silica, lime, magnesia, potash and soda, with a small increase of alumina and a considerable increase in the amount of water. It must not be assumed that the particles of residual sand have all been disintegrated and lost their original composition, for it was found upon examination that many of them still retain their mineral identity. But others, especially the alumina, has changed to the hydrous silicate of alumina. In this slow but persistent hydrating process the rock has disintegrated. After this disintegration has proceeded to such an extent that the rock will fall to pieces or can be spaded with a shovel, except under extreme pressure, the water of hydration will be given up.

Another example of decomposition of the original igneous rock is that of phonolite:*

Constituents	Fresh Rock	Decomposed Rock
	%	%
Silica,	55.67	55.72
Alumina,	20.64	22.19
Ferric oxide,	3.14	3.44
Lime,	1.40	1.28
Magnesia,	0.42	0.44
Potash,	5.56	6.26
Soda,	7.12	2.65
Loss on ignition,	4.33	7.79

There is little loss in this disintegration except a considerable percentage of the soda with approximately as large a gain in water. No phosphoric acid occurs in this rock and soils derived from it as well as from those previously given must be deficient in that element of fertility, which, in soils of this kind or formation, must be supplied. It must be recognized, however, that after disintegration has proceed-

*Merrill, Rocks and Rock Weathering. Pages 186 and 198.

ed to such an extent that the rock is converted into its mineral constituents the greater the quantity of the elements of fertility carried away, as the following analyses will show:

WEATHERING OF BASALTS

Constituents	Fresh Rock %	Partially and %	Further Disintegrated %
Silica,	43.61	43.00	43.27
Alumina,	12.26	13.90	18.13
Ferric oxide,	3.51	4.50	11.70
Ferrous oxide,	12.16	8.30	.....
Lime,	11.37	12.10	2.60
Magnesia,	9.14	7.30	3.40
Soda,	2.72	0.50	0.20
Potash,	0.81	.....	.....
Water,	4.42	9.50	20.70
Total,	100.00	100.00	100.00

As already indicated, hydration is here one of the first stages of disintegration which evidently first effected feldspars because the silica diminishes slightly and the soda and potash well nigh completely disappear, which is further illustrated by the oxidation of considerable of the iron and the disappearance of some of the magnesium and the iron, all of which elements in this case enter into the composition of these first disintegrated. In the third stage of decomposition the iron changes entirely into the most undecomposible condition, and lime decreases from 12.10% to 2.60%, magnesia from 7.30% to 3.40%, and alkalies from 0.50% to 0.20%. This same disintegration is going on in this original rock today as it did at all times, probably not at the same rate but still it is going on and the farmers who till these soils have a more definite knowledge of what their soils contain than the farmers whose soils are sedimentary in character because as appears from the analyses when these rocks have become partially disintegrated and when they are in such a condition that plant roots can penetrate them they contain a large percentage of the essential plant foods contained in the original rock. This is not true of sedimentary soils and not as true of soils formed from sedimentary rock.

SEDIMENTARY ROCK

As already indicated, sedimentary rocks were formed from the materials resulting from the disintegration of the igneous or primeval rock and are, therefore, made up of the materials little acted on by the agencies that caused the disintegration of these rocks, or of the

materials completely dissolved by the action of these agencies of disintegration, such as water, together with the gases it contains from which these substances, such as lime, were again extracted through the operation of organisms and deposited in immense beds of limestone in many sections of the State. These sedimentary rocks, covering well nigh all of Pennsylvania, are at the present time undergoing disintegration either through mechanical agencies or by the chemical action described. Limestone and the rock held together by a lime or Feldspathic cement are nearly all disintegrated by chemical action, while the greater part of the rest are broken down by mechanical action.

The following analyses of a fresh argillite from Hardford Co., Md., evidently containing considerable quantities of not completely disintegrated silicates, and therefore the chemical agencies of disintegration became operative, gives some idea of what happens when this early form of sedimentary rock again disintegrates and forms soil or residual clay:

Constituents	Fresh Rock	Residual Clay	Lancaster County Roofing Slate
	%	%	%
Silica,	44.15	24.17	60.15
Alumina,	30.84	39.90	24.20
Iron oxide,	14.87	17.61	7.65
Lime,	0.48	.....	.....
Magnesia,	0.27	0.25	.....
Potash,	4.36	1.24	4.27
Soda,	0.51	0.23	
Ignition,	4.49	16.61	3.72
Total,	99.97	100.02	99.99

The first analyses represents the fresh rock, and the second column that of the residual clay, and the third column that of Lancaster County roofing slate, which, if it had been disintegrated as the one from Maryland, would, in all probability, furnished a similar residual clay or soil. Another series of early sedimentary rock distintegrated by chemical agencies are the limestone formations such as the Cambrio Silurian, Helderberg, and others which underlies vast areas of Pennsylvania. This disintegration usually leaves a rich red clay soil, such as are found in parts of Chester, Lancaster, York, Adams, Cumberland, Franklin, Dauphin, Lebanon, Berks, Lehigh, Northampton, Huntingdon, Center, Blair, Bedford, Somerset, and smaller areas in

several other counties. These soils contain only the least soluble constituents of the original rock as the following analyses of a sample of this old magnesia limestone formation will show:

Constituents (No. 5)	Fresh Rock %	Disintegrated Rock %
Silica,	7.41	57.57
Alumina,	1.91	20.44
Iron oxide,	0.98	7.93
Lime,	28.29	0.51
Potash,	1.08	4.91
Magnesia,	18.17	1.21
Soda,	0.09	0.23
Carbon dioxide,	41.57	0.39
Phosphoric acid,	0.03	0.10
Water,	0.57	6.69

From these and many other agencies of disintegration not mentioned here we see how the original igneous rock was broken down, and again by continuous accumulations rebuilt into sedimentary rock and then by the infinite cycles of change converted into a soil upon which the immense plant life from which the coal measures of this and other states were derived was produced. From then to the present time plants and animals have been engaged in taking up and holding a share, however small, of the energy of the sun which falls in such infinite quantities daily upon the surface of this earth, that each square foot receives annually an amount of heat which, if it could be utilized in a theoretically perfect heat engine, would hoist nearly one hundred tons to the height of one mile. To get and hold this for developing a higher and higher plant and animal life, plants have come into existence adapted to soils ranging from the barren rock to soil so fertile that a plant life so luxuriant was produced that fertility is not the limiting factor but sunlight and rain.

SOIL FORMATIONS REPRESENTED IN PENNSYLVANIA

The State of Pennsylvania represents a greater diversity of soil formations than any state in the North Atlantic Division. She includes considerable areas of soils formed by the disintegration of igneous rocks in the southeastern counties. Here also occur the soils derived from the Metamorphic rock, the Micaceous, the Chlorite shist, the Hydro-mica shist. the Potsdam sand, the Cambrio Silurian limestone, the Chazy formations, then the Trenton limestone, the Hudson river series, the Utica shales, the Uneida and Medina sands, while farther north and west the Clinton, Niagara and Salina shales,

(No. 5). Merrill, page 219.

the Lower and Upper Helderberg limestone, the Oriskany sand, the Marcellus, Hamilton, Genesee, Portage and Chemung shales, the Catskill red sand, the Pocono sand, the Mauch Chunk red shales, and the Pottsville conglomerate come in, and after these the coal measures, which comprise the lower productive, the lower barren, the upper productive and the upper barren measures with their limestone, sandstone and shales, covering the western area of the State.

Then coming back to the oldest formation, we have the Mesozoic sand laid down on top of the trap and Cambrio Salurian limestone, and in some places on the Potsdam sand formations. Later than this in the western, northwestern and northern counties of the State come the potters and fire clay and sands, Post Tertiary, the terminal Moraines and alluvial soils. Upon these formations, in many places so intermingled, that it is difficult to tell which predominates. Nature began producing crops which continued for ages until, in many places as already indicated, the fertility was so highly developed and the crop yield so luxuriant that the struggle between the plants was no longer one for fertility but for sunlight.

A CONSTRUCTIVE AGENCY

From what we have seen, it is evident that the first soils came into existence upon the disintegration of rock by atmospheric agencies, the physical, solvent and chemical action of water all directly traceable to the energy of the sun. The action of the gases such as Carbon Dioxide and Oxygen held in solution by water is invariably more pronounced on the minerals containing one or more of the elements that form compounds soluble in water or compounds made soluble by the action of the gases held in solution by water than upon elements not so affected. The feldspar minerals known as Potash Feldspar, Soda Feldspar, Soda-lime Feldspar, Lime-soda Feldspar, Lime Feldspar contain elements such as potash and lime essential to plant growth, readily acted on by water or the gases held in solution in water and converted into soluble compounds. Wherever this operation has begun plant life such as algae and lichens, and mosses will appear to take up and put into organic compounds these essential elements of plant food and hold them until the agencies of decomposition have converted them again into available plant food. Here decomposition and disintegration begin to work together, the former a chemical action the latter evidently a vital one.

These plants have appeared under well nigh all climatic and soil conditions and we have, as Warming shows in his Ecology Page 136, 1, vegetation growing on water covered soils or formations in water; 2, vegetation in marshes; 3, vegetation on soils that are comparatively dry but too wet for organic matter to decompose, which, therefore, makes sour soils and produces acid soil vegetation;

4, cold soil vegetation; 5, saline soil vegetation or the vegetation of salt marshes; 6, rock vegetation, already referred to; 7, vegetation on course sand or broken rock; 8, vegetation on soils in very dry climates; 9, vegetation on Savannahs; 10, bush and forest formations; 11, complete forest formations, and 12, formation ready for agricultural plants.

It is evident that well nigh all of these types of vegetation prevailed in the various sections of this State from the earliest elevated soils which were formed upon the uplift of the Appalachian Mountain system, which began in early Cambrian time and terminated at the close of the Carboniferous Age, and are now engaged in doing over and over what they and their more primitive ancestors have done in the ages past, during which likely more soil was formed in this mountain system than still remains. During all these ages as at the present time there occurred flat or rolling rock formations, rocky slopes with numerous declivities and chasms, at different angles with northern, eastern, southern and western exposures with hard rock and soft rock, rock of various composition, rock easily acted on by atmospheric agencies, rock not so readily acted on by these agencies, rock over which water slowly trickles, rock bathed in burning sunlight, rock in the shaded gully, rock exposed to the prevailing winds, and rock sheltered from these. Under such conditions a variegated rock vegetation occurs each one specially adapted to its environment but each slowly or more quickly working for the same purpose, that of soil construction.

These lowly plants, called Lithophites or rock plants, include algae, lichens, and mosses (No. 6) are dependent on each other for support, one supposed to furnish mineral nutriments by means of roots or rhizoids, another water, and still another, carbonic acid from the air with such a co-operative equipment these lowly organisms together with the agencies already described have been and still are at work on the everlasting hills and mountains, some the lime-loving varieties on the limestone, others the silica-loving kinds on granite trap sand stone, etc. The limestone formations being more readily acted on by atmospheric agencies, are more easily and completely colonized by these lowly plants, because upon these the lichens can fasten their rhizoids and the algae their filaments and assists the atmospheric agencies in their disintegrating operations and soon prepare a soil for more highly organized species, the earlier of which are mosses and fructose lichens which retain more and more of the essential elements of plant food obtained from the rock and more and more moisture and accumulate a larger and larger quantity of organic matter until club mosses and ferns find a congenial soil environment and establish themselves. The closer the rock formation approaches the flat or horizontal position the more perfect and

(No. 6). Mosses and Lichens, Nina L. Marshall.

extensive will the soil formation develop, whereas, if the rock formation be more or less steeply inclined and the atmospheric agencies of disintegration have started their work and the lichens and mosses have fastened themselves and have started the accumulation of organic matter, and small quantities of soil are formed it will be washed into clefts of smaller or larger dimensions in horizontal or flat spaces, and here in a shorter time because of the faster accumulation of the soil will be produced a plant life similar to that on the rock lying flat.

Another species of plants with long roots and long creeping rhizomes establish themselves upon the talus of hill and mountain sides extending these down through the crevices of the talus and extract mineral nourishment and with the same organs when partially or completely covered by a fallen talus reach out and again rise into the sunlight, in this way making a deeper and more extensive root system furnishing more fertility and moisture and sunlight so that the adversities that would destroy agricultural plants work together for good to these pioneer soil makers.

COLD SOILS

Cold soils are cold because of location such as the soils in northern regions and on high mountains. These soils produce a dwarfed plant life especially adapted to an environment in which there may be frost or snow any day or night during the growing season. Similar climatic changes prevail in the Torrid zone going up a mountain side as takes place going north from the Equator, but the plant life on the snow capped mountains here differs from the plant life on the mountain in the Temperate zone, which is similar to that of the Arctic regions because, in the former case, there is a little change in the temperature, wind, rain and amount of sunlight on top and at all points on all sides of the mountain as there is on the plain at the base; whereas, in the Arctic region there is a long day and a long night, and in the Temperate zone the rays of the sun are so slanting during half the seasons that their effects are similar to that in the Arctic regions, and consequently the plant life is similar.

SAND VEGETATION

The vegetation that first appears and adapts itself to sand and gravel such as occurs on the slowly moving sand dunes on the lee side of Lake Michigan are some of the sandworts followed by milkweed and the scouring rushes. These and many others produce sufficient organic matter, that within a few years, the lee side becomes overgrown with shrubs and trees which finally produces a forest in which poplar, oak, ash, sassafras, and even walnut and other trees grow. The vegetation on the sandy soils of some of the

Atlantic Coast states passes through a similar evolution, with species adapted to the environment until a soil sufficiently rich is produced and these sands become clothed with pine forests.

SOILS FROM VOLCANIC MATERIAL

One of the best and most frequent opportunities for illustrating soil formation from bare rock or rocky and stony materials through the agencies of vegetation, is furnished by volcanic eruptions which cover tracts of land and destroy all vestiges of vegetation. (No. 7) The eruption of Krakatoa in 1883 furnishes an example well remembered by this generation. Treub who investigated the lava fields came to the conclusion that the lava and pumice first became clothed with a thin film of simple one celled blue green algae and similar simple formations which prepared the way for the germination of abundant fern spores. Three years after this eruption, the new flora on this lava field consisted entirely of ferns, while plants with true seeds began to occur here and there along the water courses or on the mountains. Beccan found that the island of Sambava, which had been denuded of all vegetation and covered with lava by an eruption of the volcano Tamboro in 1815, was clothed from base to summit in 1874 with a virgin forest, all produced in the space of sixty (60) years.

LANDSLIDES

After the forests have been cut away from the hills and mountains of Pennsylvania and these have been burned over several times, land slides frequently lay bare acres of rock. Here the same constructive agencies begin operations, first, rock plants, lichens, algae, and mosses whose rootlets penetrate the rocks more or less deeply, depending on its hardness, porosity and its exposure to heat and cold and the presence or absence of water. The remains of these plants as time goes on, together with disintegrated rock and dust unless the decline is too steep, provide a scanty soil in which more highly organized plants can grow. Along the line of the old Tapeworm Railroad, in Adams county, Pennsylvania, are cuts made more than seventy (70) years ago through the Azoic rock from which there were land slides laying bare the rock upon which these lowly organisms have been at work during all these years, and they together with more highly organized plant life that came along later have formed a soil sufficiently fertile to produce shrubbery and trees six and more inches in diameter. On the fills of this railroad entirely composed of the rock blasted from the cuts through which it passes in this mountain trees even larger than those already referred to have grown and the crevices between the rocks and stones are well nigh filled with humus and disintegrated rock.

(No. 7). Warming, pages 350-352.

FOREST FIRES AND NEW SOIL FORMERS

Forest fires have been the most powerful agencies in changing the soil conditions of the hills and mountains of Pennsylvania, which at one time would, after the woodman's axe had cleared away the primeval forest, within a few years start a growth so luxuriant in many instances that the contention or struggle for existence between the species endeavoring to grow would not have been for fertility but for sunlight. These same soils after having been burned over again and again the organic matter burned off the surface, the seeds and living roots of the former shrubs and forest trees as well as the rhizomes and spores of highly developed allies or lowly organisms killed, here species of plants of an inferior character are now eking out a struggling existence. On the table land of the South Mountain, which at one time was covered with a dense forest of pine, all of which has been cut away and since then this land has been burned over again and again by the berry gatherers until today it is covered with a growth of scrub ground and Jerusalem oak, with here and there a scrubby pine of little value for firewood and less for any other use. And what is true of the South Mountain is true of many hills and mountains in Pennsylvania.

But besides the inferior growth already referred to, the soil has become covered with a dense mat of lichens, algae, and mosses of great variety which cover the sand to a depth of several inches, and which are not so readily effected by fire, and which, after the fire has inflicted its ravages, take advantage of that inherent co-operative quality of absorbing moisture from the air and soil and holding it for the inferior plant life that has taken up the work of soil rehabilitation in these mountains. While these lowly organisms hold considerable water and acquired fertility, they do not hold these as does a forest-clad hill or mountain with its roots and undergrowth and leaves, therefore, when heavy rains fall these mossy grounds become saturated with water and hills and mountains begin to wash down and the washing, roots up, well nigh all plants and the destruction of the hills and mountains has begun, and all on account of forest fires of which more are due to the carelessness of railroads than to all other sources of forest fires in this state combined. With the fire brand absolutely removed from these hills and mountains, it will require not sixty (60) years to re-construct forests and the undergrowth of our forests as it did in the eruption of Somboro, but within thirty years a new forest will be constructed and soil construction on our hills and mountains will again go on in this State as it did in the immeasurable ages of the past.

What is true of soil destruction by the fire brand and of soil construction by forest growth, is true of soil destruction by farming in which more organic matter is burned out than put into the soil,

and the methods of farming, by which a little more is added than is taken out. Upon such soils, with good farming better and better plant life will grow. Such soils will not be like so many soils in Pennsylvania are today after having been farmed many of them for more than a century and after having been sown with good seeds such as clovers, timothy, redtop, etc., for this length of time will when the soil is un-occupied by a crop, produce a horde of weeds instead these constructively farmed soils will produce crops useful for man and beast.

PLANT LIFE IN LOWLANDS—FRESH AND SALT WATER

The development of plant life along and in the water follows well nigh the same lines of development as do those upon rock and partially decomposed rock, except that in many instances it is very much faster. Water mosses and algae as well as other low water loving plants, such as eel grass and glasswort, grow along close to and sometimes in sea water. In fresh water besides the mosses and algae, plants are usually arranged in zones depending on the depth of the water and the kind of soil under water. In shallow, deep and running water the Characeae a family of plants allied to the algae, grow, while the thousand leaved or water Milfoil grow under water. The pond weed family and Spatterdock, and the White Crowfoot all find a congenial environment closer to the shore, while beyond these the reed family especially in warmer climates find a congenial soil. As seasons come and go the remains of these plants together with the accumulation of decomposed rock under the water as well as that brought by currents of water and wind build up until the bottom of the body of water is raised sufficiently for marsh plants to take the place of the pioneers already referred to among which the water parsnip, the rush family, the Horse tail, etc., are among the first. When the soil is raised sufficiently above the water, grasses begin to appear, later meadows, then willow and alder bushes and finally forests.

Successions of development vary with localities and climatic conditions and may be produced in many ways; for instance, bog mosses may do the pioneer work and upon these soils members of the heath family, to which the cranberry belongs, then the birch family of trees, then the pine family, then, depending on the locality if in the southern part of the State, the swamp Spanish or pin oak, later when the soil is dryer and more fertile, comes the swamp white oak, then the lowland black oak, and finally the white oak. All the causes that are responsible for the changes and improvements in vegetation on barren rock and in water during the past ages is difficult to decide; but that such improvements have taken place is undoubted. Climatic changes and conditions certainly played an

important part. But it is evident that with the increase of organic matter in the soil, more exacting species displaced the more accommodating and when humus decreased the more accommodating species appeared again. This has happened in many places in Pennsylvania soils which were at one time covered with hard wood forests or some of the exacting species of which they were cleared and farmed for years, then abandoned, are now endeavoring to grow spruce, hemlock and pine forests or scrub oak all belonging to the more accommodating species.

The same thing is taking place on the depleted cotton and tobacco soils in the Southern states where the scrub pine takes up the process of soil rehabilitation. This soil constructive operation by means of rock disintegration and humus accumulation has gone on in this State during immense ages and is still going on until a vast acreage of soils ranging from a few feet to more than twenty feet in depth ready for agricultural plants has been formed.

With this constructive process, the farmer with his methods has, in many instances, interfered, which nature, as soon as his destructive hand is withdrawn, again takes up. The farmer and farming methods must no longer be destructive, but like nature constructive. As already indicated, the process of disintegration is still going on and will for ages to come and will slowly make available, by means of solvent agencies, whatever plant food may be contained in the disintegrated rock and the agricultural plants will take up the made available mineral fertilizing elements, build these into plant tissue, and unless removed from the soil by man for his own use or to be wasted, will return all to the soil for the use of new generations of the plants, so that where the soils are sufficiently developed for growing agricultural plants, nature still continues her constructive operations, an undeniable evidence that man with right methods, which are in harmony with nature can also be constructive.

Here the assertion will be made that the farmer can not return all he produces on the soil back to it. He must use these products for his own and the maintenance of the lives depending on him as well as all the non-producers of farm products, and, therefore, can not return these to the soil, all of which is very true. Here then the question naturally arises, is it right for the farmer to continue a practice which, if followed indefinitely, will render useless the soil, the medium into which he sets his plants for entrapping the solar radiation and store it to furnish human nutrition, or shall he adopt a practice by which he can produce all crops necessary for human nutrition and return in sufficient quantity all by-products that the soil can work over into available plant food and in this way maintain its productive capacity indefinitely.

Here the higher than nature's function of the farmer appears that of so utilizing the by-nature's processes constructed soil for growing agricultural plants that these will yield the largest and most available food supply for human nutrition, and at the same time, retain and even enhance the productive capacity of the soil. This dual function of the farmer, of food producer or energy furnisher for all human activity and soil fertility maintainer and enhancer, makes him the agent by whose labors are furnished the nutriments which operate the bodily mechanism of all those who are employed in the agricultural, manufacturing, mining, transportation, commercial, educational, governmental, religious and all other systems in our intricate civilization, as well as the conservation of that medium upon which depend the existence and possibilities of all these and whatever systems future developments may add to them. With such responsibilities resting upon him, this farmer, of all men, should also be the most highly trained in his art, so that mankind, in a land flooded with an immensity of solar radiation and rain, it would be impossible for humanity to go hungry much less to starve.

CROPS CONTAINING HUMAN NUTRITION

Of all the foods produced by the farmers of this State, the cereal grains contain the largest quantities of the most easily made available carbohydrates, fats, proteins and mineral salts required to operate the human body, and among these, wheat is first. The State has a large acreage well adapted to its growth, and not only this, but a considerable acreage upon which a superior type of wheat can be grown. The question will naturally be asked, Can this crop be made to fulfill the dual function of the farmer, that of furnishing food for mankind and maintain the fertility of the soil? Nearly all of the wheat kernel beneath the skin, or that part which makes the bran, is available for human nutrition. A crop of 20 bushels of good clean wheat per acre or 1,200 pounds, a quantity raised in most of the wheat-growing sections of the State, contains about 28.50 lbs. nitrogen, 11 lbs. phosphoric acid and 8 lbs. potash, and will make between 800 and 900 lbs. or a little over 4 barrels of good flour, containing, according to analysis (Bulletin No. 15, Experiment station work U. S. Dept. Agri. table 2) about 18 lbs. nitrogen, 4.70 lbs. phosphoric acid and 4.40 lbs. potash. The straw, estimating 2,500 lbs. per acre, contains 24.75 lbs. nitrogen, 3 lbs. phosphoric acid and 12.75 lbs. potash, making a total from both wheat and straw of 53.00 lbs. nitrogen, 14.0 lbs. phosphoric acid and 20.0 lbs. potash.

If all these products would be sold and taken away from the farm, the soil would be deprived of the fertility they contain and the organic matter, which is so potent a substance in soil construction as well as other functions in maintaining its productiveness. Such an

operation would be out of harmony with the processes of nature and with the dual functions of the farmer. The flour represents only, approximately, 25 per cent. of the wheat crop, and is directly available for human food. Of the 75 per cent. not available for human food, about 10 per cent., the bran and middlings, are especially adapted for animal nutrition, and through the animal, a part of these by-products can be converted into human food, and the part not so converted returned to the soil in the excrement of the animal, which contains about 80 per cent. of the fertility in these feeds. If only that part of the wheat crop available for human nutrition is sold off the farm and the bran and middlings, are fed to animals on the farm, the straw used as absorbent for the animal excreta derived from these feeding stuffs, then well nigh all the fertility contained in the bran and middlings and all that contained in the straw amounting in both to about 25 lbs. nitrogen, 10 lbs. phosphoric acid and 16 lbs. potash per acre, together with the organic matter these contain, are returned to the soil, while only about 4 lbs. phosphoric acid and 4 lbs. potash, mineral elements of fertility contained in the flour, must, by future crops, be obtained by further and deeper rock disintegration, or be supplied by the application of commercial fertilizer and the nitrogen amounting to 17 lbs. per acre gotten from the air through leguminous crops. How long a soil would continue producing wheat in paying crops by returning to it the straw partly used as absorbent for the excreta of the animals fed with the bran and with the remainder of the straw as roughage and by supplying the fertility contained in the flour by the application of commercial fertilizer, I do not know, but I am willing that it should be compared with the method of selling all the straw and grain and applying commercial fertilizer to supply what has been sold.

The cereal crop furnishing the largest quantity of human food best adapted to the needs of the body next to wheat, is corn. A crop of 40 bushels of shelled corn per acre, the average yield in this State for the past few years, contains 44.0 lbs.* nitrogen, 17 lbs. phosphoric acid and 9.74 lbs. potash in the grain and the fodder estimated at 4,000 lbs. per acre contains 41.6 lbs. nitrogen, 11.6 lbs. phosphoric acid and 56 lbs. potash, making a total for the crop of 85.6 lbs. nitrogen, 28.6 lbs. phosphoric acid and 65.74 lbs. potash. From these data it is evident that on farms from which the crop of corn is sold and the fodder wasted in a most shameful way, as is the case in many sections of the State, that there is an enormous loss of fertility and that soils with such treatment must be exceedingly well supplied with the elements of fertility or they would cease to produce any crops. The reverse, however, is just as true as is well demonstrated in the cattle feeding sections of the State where all the corn and a large part of the fodder are fed to steers and where at least 80 per cent.

*Bulletin No. 15, U. S. Dept. Agri. Table 2.

of the fertility contained in the grain, a large part of the organic matter contained in the fodder, especially that part used as absorbent, are returned to the soil directly from the stable or pen. Here there is no such thing as worn out soils; but these soils become better and better, and the likelihood is that such a system of farming with careful management, specially if the corn fodder used as absorbent, would be shredded could be carried on indefinitely. But according to Dr. Armsby, only about 3 per cent. of the solar energy stored in a bushel of corn is recovered in the edible carcass of the steer to which it is fed. This method of using food 81.4 per cent. of which is digestible, a very large part available for human nutrition is entirely too wasteful and expensive and is a method of farming more for maintaining soil fertility than for human food, whereas, wheat farming is farming more for human nutrition than for soil fertility, therefore, will a combination of the two furnish a larger amount of human food and at the same time maintain the fertility of the soil. This naturally brings us to crop successions or the combinations of agricultural crops so as to get the largest quantity of human food and at the same time do constructive farming.

CROP ROTATION, LIME AND COMMERCIAL FERTILIZER IN CONSTRUCTIVE FARMING

Crop rotation or succession or having different crops follow each other on the farm was practiced in the Eastern states especially in Pennsylvania for more than two centuries. In the early stages of agricultural industries in the Atlantic Coast states, especially the so-called Middle Atlantic states, it was necessary for the farmer to produce all the food needed for himself and family, and his help on the farm as well, as that needed for feeding the animals on the farm, and therefore he raised wheat, rye, corn, buckwheat, potatoes, etc., for himself and family and corn, oats, barley, rye and hay for his animals. This early farmer, therefore, had a wheat field, a rye field, a corn field, a potato field and a hay field.

If tradition can be trusted and the primitive practice of the Southern farmer is an indication of what had been the practice in the more advanced states in agriculture, then this farmer raised these crops on the same field year after year. In the more advanced farming section this primitive practice was abandoned more than a century ago, because the farmer saw that wheat can follow oats as well as wheat can follow wheat or that a short season summer oat crop could be raised in well nigh all the Northern states and a long season winter wheat crop started as well as if the field had been sown with wheat and that the short season summer oat crop can follow corn as well as the short season summer corn crop can follow corn. And still farther, the farmer found that a sod field when well plowed

(after the iron plow had been invented) would produce a larger corn crop than a field upon which corn had been grown year after year, then why not plow up a sod field that no longer produces a paying hay crop. With the knowledge that larger crops can be raised with crop rotation and with the invention of soil culture implements, rotations became a panacea for all crop failures. This field produced a crop of corn and, therefore, it should be in good condition to produce a crop of oats the following Spring, was a general comment by the farmers of those days. These farmers contended that the soil was made more fertile by crop rotation and therefore in order to keep up the fertility of the soil and increase the crop yield the only thing necessary was to raise a different crop on the soil as frequently as possible. Why there should be a decrease in yield by the succession of the same crops on the same soil in even so short a time as two seasons is difficult to explain. Whether this condition in the soil is the result of toxic substances produced by the plant refuse, or whether it is the inability of the succeeding plant making the same demand on the soil to find sufficient plant food suited to its taste or whether that fertility has been contaminated by the proceeding plant so that even if it be present in abundance the plant will not utilize it or whether there is an inherent quality of the soil of being more kindly disposed to a succession of different plants than to a succession of the same plants, has not been determined.

This is not the place to discuss and theorize on this subject. As above stated short and long season crops were made to follow each other, such as oats and wheat, or two short season crops such as corn and oats which were raised in approximately the same time that was required for raising one long season crop of wheat. With the more indolent and indifferent farmer, crop rotation was an easy way to keep up the productiveness of the soil because, if a succession of crops will keep up the fertility, then he did not need to apply manure which consequently he did not do. He did not need to cultivate his soil especially and therefore the oat field was not well prepared for seeding wheat, neither the corn field for seeding oats, nor the sod field for planting with corn, because a different crop will thrive independently of all these; but the time came when crop rotation failed to bring the results its early adoption promised. Early in the nineteenth century a large acreage of the farming land of the Middle Atlantic states where crop rotation had been developed to its utmost and had failed, was regarded no longer adapted to farming and was not farmed and those who owned it sold out and went farther west and began to do over again what they and their ancestors had done in the east, either by following crops of the same kind or having a rotation of different crops, ending with a repetition

in many instances of a reduction in yield to such a degree that further westward emigration was taken up by the more shiftless farmer who simply raised crops for the money that was in it regardless of the effects on the soil and when returns from the soil were no longer satisfactory, he was either ready to move again or to try other means of soil improvement.

The farmer who remained and tried other means of soil improvement is still trying these other means of soil improvement. The first of these was the use of well rotted manure. Manure not well rotted was regarded of very little value to the soil. With so perverted an idea of manure, one-half and many times two-thirds of the value of the manure was lost during the process of decay in the barnyard or wherever it was piled up unless protected by a covering of some sort. On account of the loss sustained by handling the manure in this way, a way that is still in vogue in many places, there was not a sufficient quantity of manure to keep up the organic matter farmed out of the soil by crop production, and so much of the fertility the manure contained was lost by leaching and decay outside of the soil that there was a continuous decrease along both lines which resulted in a lessening and lessening of crop production as time went on. Soil stimulants were tried, among them salt and lime, plaster on ground gypsum with, in many instances, gratifying results, but these were as ephermeral as crop rotation and the application of small and leached quantities of manure. Late in the eighteenth or early in the nineteenth century when crop rotation and the application of the small quantities of the leached and well rotted manure had failed and when crop failures were common and when a large number of the young men of the Middle Atlantic states and the Northeastern states were leaving the more eastern settlements and going farther westward and as already stated did again what had already been done, another method of soil improvement came into vogue, that of applying lime to the soil. Within a few years after the application of lime, crop yields were doubled wherever lime was applied and liming became universal in the grain and grass raising sections of the Eastern and Middle Atlantic states. Liming together with crop rotation, the application of well rotted manure and the plowing down of sods, a practice followed by the more advanced farmers, was destined to become a more effective agency of soil improvement than had up to this time been introduced by the farmer.

It must be remembered that caustic lime was the form of lime, used at this time. At first small quantities were applied, and when it was noticed that so small a quantity produced such wonderful results, the farmers concluded that with the increased application of lime, the crop yield would increase and therefore as much as three hundred bushels, or twelve tons of caustic lime was, in many

instances, applied to an acre, and if the soil happened to be sandy, shaly, loamy or, in many instances, a large number of clayey soils were made so caustic that they did not produce any of the agricultural crops for a year or more, then the evil effects of lime became evident; but they were not understood. But lime, like crop rotations, too, failed, then came commercial fertilizer containing the elements of fertility in which many soils seem to be deficient, and up to the present time has held the stage whether it will continue to do so, the future of agriculture will decide.

It is evident that crop rotation, liming and commercial fertilizer are not the panaceas that will cause the soil to produce crops for human food, the limiting factors in which are sunlight and rain, but that each one of them can be used in an effort in bringing about so ideal a condition cannot be denied. A crop rotation that will furnish the largest amount of food for human nutrition is one in which the cereal grain that can be successfully grown in Pennsylvania, such as wheat and corn, occupy the largest acreage, where the soils are sufficiently fertile and the season long enough which is the case in the southern but especially in the southeastern section of the State to raise clovers between the long season, and the short season corn crop, the following succession could be followed. Beginning with corn, which should be planted not later than the middle of May, and should be a variety that will ripen early in September when it is cut near to the ground and drawn together in large shock rows and the ground which if the corn has been cultivated as it should have been will be in good physical condition and will need only the preparation that a well cultivated, plowed after harvest, stubble field, will need to put it into condition for sowing with wheat about the latter part of September. After the wheat is harvested the following summer the soil is disked and sown with cowpeas. They will in a normal season, especially if Northern grown seed is sown, grow until the middle of September when, if they have made a sufficient growth, they can be made into hay and used as roughage and the ground again disked and sown with rye and hairy vetch or, if the growth is not large enough to make hay, they are plowed down, the soil put into good cultural condition and sown with rye and hairy vetch and these if possible made into hay the following spring or plowed down and the ground planted with corn.

In a rotation like this there would all the time be a growing crop on the soil to take up whatever fertility might become available and to entrap and store up the energy of the sun, and in the case of the clovers, procure nitrogen from the air and build all these into plant tissue to be used as food for animals and all straws and bi-products converted into fertility, and these in turn furnish food for man. No

pasturing of animals is possible in a rotation like this (except the cowpeas might be pastured for a few weeks by hogs) and, therefore; some of the corn should be siloed and the animals fed with silage, and whenever possible the rye and hairy vetch should be made into hay for the animals as well as the cowpeas. The only products sold off this farm are the flour and the animal products, whether beef, pork, or milk derived from feeding the bran and middlings, corn silage, corn fodder, cowpeas, rye and hairy vetch hay, and the straw and the corn fodder and manure of the animal returned to the soil to keep on building as nature did. If the main desire was to get all the available human food out of these two crops all the corn except that needed to feed the animals could be sold and the roughage together with the manure and some commercial fertilizer returned to the soil. A rotation like this is not suggested for any section of the State except for the less elevated southern sections, especially the southeastern, where grain raising and in many places hog and cattle fatting has been made an industry.

Another succession of crops in which the cereals occupy the largest acreage and one that will furnish a large amount of human nutrition and organic matter to return to the soil and is adapted to well nigh all sections of this State, is made up of corn, grass and wheat.

Beginning again with corn which, in this case, may be a variety that will take up the entire season at any locality in the State to ripen the crop, because the crop of grass which is to follow corn will be sown with the corn about the beginning of August and no crop will be sown after the corn is cut.

The grass or clover crop may be all clovers composed of equal quantities of red and alsike or some alfalfa may be added for part, the alsike or it may be all red clover or where the crops have been successfully grown, it may all be alfalfa or a mixture of red alsike alfalfa and timothy sown, sometime early in August in the southern section of the State and probably better, the latter part of July in the northern section. Level cultivation must be practiced and the corn must be cut at the ground so that there shall be no corn stubble. In a good well cultivated soil with good clean seed sown with an inter row seeder, this will produce a crop of hay the following June. A second crop will grow, especially if the clovers have been sown or can be pastured for some time and then plowed down and the ground put into condition for wheat. Sometime in April of the following spring the wheat field is sown with clover and timothy and is cultivated with a weeder and the seed covered with the weeder. This will make a crop of clover for a fall hay crop if the soil is strong or for clover seed and for plowing down the sod the following spring to be planted with corn. In this rotation the long

season hay crop is sown with the short season corn crop and the long season wheat and clover crops are made to overlap the same as the hay and corn crops and in this way there is always a clover sod to plow down for wheat and for corn. The flour of the wheat is one of the money crops and is sold, the bran and middlings are fed, the straw is used as absorbent and therefore only the fertility contained in the flour of this crop is not turned back to the soil.

In rotation like this, some of the corn should be siloed and some of the grain in connection with some cotton seed meal fed to animals and some might be sold in the grain without injury, especially if cotton seed meal is used.

Here we have a two years, three years and the old four or five years succession or rotation of grass, corn, oats, wheat and some times wheat a second time, and then grass a rotation is very largely followed by well nigh all grain farmers in the State, but is not calculated as now practiced to either furnish the largest amount of food for human nutrition and at the same time maintain the fertility of the soil because usually there is only one clover crop in four years and the whole wheat is sold and sometimes a large quantity of corn and hay and even straw and the grass or sod fields pastured down to the roots and the soil compacted that it cannot breathe and the very life is pressed out of it.

The old rotation is a good one and the reason that it does not perform the dual functions of the farmer is because it is abused. As we have already seen, it is the interlocking of long and short season crops in the two and three years successions to produce the clovers and the organic matter and by selling only the manufactured human nutrition in the shape of flour and animal products and by turning all animal excreta and roughage back to the soil that it is possible to maintain its fertility. This same thing can be done even more effectively in the four or five years rotation. Corn is a short season crop and so is oats. These two crops usually follow each other. If it is not possible to raise one of the short season clovers, such as crimson or the winter hairy vetch with some rye to sustain it and to furnish organic matter in which the soils that have been farmed in the manner already stated are deficient, sow a mixture of three quarts crimson clover seed, three quarts hairy or winter vetch, one-half pound cow horn turnip or any other beet seed that may be desirable and a half a bushel rye to the acre with an inter row seeder. Some of these will grow and furnish some organic material to construct soils. Plow down this crop the following spring and sow oats and with it four quarts Mammoth or red clover seed, or better still, oats and Canada field peas, a clover with one of the grasses. In the southern section especially the less elevated if the season should be late soja beans, a clover can be sown instead of oats. These will

ripen and will be out of the way in time to prepare the soil for wheat. Some places one wheat crop follows the oats, other places two and with these timothy and clover are sown the former usually in the fall of the year and the latter some time in the spring. In the northern section of the State the wheat is cut out of this rotation and the clovers and grasses are sown with the oats.

This old four or five or some times six years rotation can be made more constructive than either the two or three years succession because with the corn a short season crop, a short season clover can be raised with and after it, and the oats and Canada field peas both a short season grass and clover and Mammoth or red clover with the wheat the first year, if wheat is to be followed with wheat the second year and timothy and clover for hay the last year. Plow down the crimson clover, hairy vetch and rye unless conditions are such that a crop of hay can be made of these, than make hay, feed this to animals and convert it into edible human nutrition, sow the field with oats and Canada field peas or oats and Mammoth or red clover, or if the season is late, with soja beans. Make hay of the Canada field peas and oats if these were sown or if oats, leave it ripen, harvest and allow the clover to grow until time for plowing for wheat which may be late in August or early September. Do not pasture—for this is always bad and injurious to the soil. If soja beans have been sown, make these into hay or leave them ripen and thresh and use the seed for feed for animals after grinding, and prepare the soil for wheat and sow as already indicated.

The usual manner of disposing of the crops and roughage from this old four, five or six years rotation is to sell the whole wheat, a large part of the corn, some of the oats, hay and straw, raise only one clover in the four, five or six years, pasture this down several times to the roots, pile up the straw and the unshredded corn fodder together with the excrement of the animals for which these were used as absorbents while the animals were housed, or while in the barnyard apply this barnyard manure once or twice a year to the soil and then atone for this kind of soil treatment by applying some commercial fertilizer. This practice is not excusable in this State, but bad as it is, it is better than two-thirds of the agriculture practice in this country.

In order to furnish a legitimate amount of human nutrition from this operation and continue soil construction, sell the flour from the wheat, feed the bran and middlings, sell some of the corn, feed the remainder, feed the oats, or the Canada field peas and oats or the soja beans, silo some of the corn, feed this, shred the remainder of the corn fodder, feed it together with the clover hay, sell the animal products derived from these feeds, use the straw as absorbents for the animal excrement, apply the stable manure as made, to the grass

field whenever possible until it is covered, than to any growing crop that may be convenient and with such fertilizer or lime as the crops may indicate, this soil will retain its original producing capacity and increase it. In the case of the rotation in the northern section of the State from which wheat is eliminated the corn and oat crops are the only cereals salable and in many instances oats the only one. Climatic and soil conditions are especially favorable here for the raising of oats and, therefore, it should be made a crop of commerce from this section and the rotation so arranged that this could be done. A succession of crops already indicated is grass after grass, corn, then oats and then back to grass. An improvement on this would be a clover, such as the hairy vetch sown with the corn, sometime in August, sown with an inter row seeder. A half pound of cow horn turnip would not hurt to be sown with the vetch. These plowed down the following spring and the ground sown with oats and Canada field peas and then to grass. The land sometimes remains in grass for three or four years, so that frequently two-thirds of the farm is in grass. When this is the case and it is at all possible, alfalfa should be made the hay crop and should be sown with the oats. With alfalfa, corn and corn silage fed to animals, the manure used as already indicated all the oats could be sold and still the soil's productiveness maintained especially if some concentrated feeding stuff, such as cotton seed meal and suitable commercial fertilizer would be used in sufficient quantity to supply the fertility sold with the oats, and the animal products derived from these feeds which are also converted into money.

Many of the farms have large acreages in permanent pasture which, in many instances, has badly run out and should be made to produce more, both for human nutrition and for keeping up the productiveness of the soil. Probably one of the quickest and best methods of bringing these soils back to their original productiveness can be accomplished by plowing up the old sod as early in the spring as possible. Disk harrow a number of times, and put into the best cultivated condition, and if advisable, plant with corn and raise a crop of corn; but it seems a better plan would be to sow with buckwheat, and four or five quarts crimson clover or a half bushel of winter vetch to the acre. After the buckwheat is harvested, allow the crimson clover or vetch to grow until the ground must be gotten ready for sowing rye and hairy vetch. The rye and hairy vetch can be made into hay the following spring and fed to animals and the manure applied to the soil or to get into more definite harmony with the purpose advocated, that of producing human nutrition and fertility, the rye and vetch can be plowed down and the ground prepared for corn and the corn either siloed or allowed to ripen and in either case fed to animals. After the corn is cut and the ground prepared,

it can be sown again with rye and hairy vetch, but what is still better, clovers and timothy or alfalfa can be sown with the corn, sometime late in July or the beginning of August and in this way without any more cultivation than the corn should have, the soil is brought back into grass. Here is a crop of buckwheat for food for men and animals, a crop of crimson clover to plow down, a crop of rye and hairy vetch for hay and the stubble to plow down or depending on conditions, the whole crop to plow down, a crop of corn to be converted into human nutrition and the remainder returned to the soil and the ground back into grass. This may take only two years or it may take four or six years, but whatever time it may take, an operation like this or another that will accomplish the same purpose that of producing crops for human nutrition or rehabilitating the soil is worth the while and should be done. A soil handled in this way will stop growing weeds and instead will grow agricultural crops.

HUMAN NUTRITION FROM ANIMAL PRODUCTS

In many sections of the State milk and butter dairying are the chief agricultural industries, because the farmers get larger financial returns from these than they do from raising the larger amounts of human nutrition in the cereal grains, therefore, a succession of crops should be arranged to furnish food for the dairy herd, containing the ingredients to give satisfactory returns and at the same time build up the soil without the purchase of large quantities of concentrated feeding stuffs.

The cereal containing the largest quantity of available animal nutrition raised in Pennsylvania is corn, but it does not contain a sufficient quantity of the proteins to give the best results in animal products. Therefore, the question arises, Can this deficiency in this cereal be supplied or other feeds produced on the farm and financial returns obtained equal to those gotten from the feeding of concentrated feeds and at the same time maintain the fertility of the soil. This can be done in several ways either by raising a high protein containing a legume, such as the Canada field pea in the northern section of the State and some of the varieties of the soja beans in the southern section or by raising and feeding a high protein containing roughage. The latter seems the more feasible, because the Canada field pea frequently does not produce a large quantity of seed and the soja beans, sometimes acts in a similar way and when it does produce seed it shells out so easily that a large part is lost. The animal should not be overfed with roughage and underfed with grain, but the roughage ration and the grain ration should be arranged to accommodate the capacity of the animal, and to do this, certain quantities of the concentrates may have to be supplied for

some individual animals. It will, therefore, not be necessary to supply a larger quantity of the superior roughage than what might be termed the inferior.

Roughage crops, especially silage, are heavy and bulky and, therefore, difficult to handle and for this reason, the barns where the animals are kept should be located at such a place on the farm, so that the fields would be as close as possible to it, so as to make hauling distances as short as possible while at the same time have the barn as accessible as possible otherwise.

Silage is a heavy crop and difficult to handle and should, therefore, be raised right by the silo. As already indicated, roughage could more likely be the high protein food in this operation and, therefore, silage, the main one of these feed should be high in protein and for this reason at least half of it must be a clover. The land upon which the silage is to be raised should be right by the silo and should contain a sufficient acreage to be divided into two sections for a two year's rotation, one to be planted with corn, the other with soja beans, a clover or any other suitable legume the first year, the next season reverse the order and so on. A short season clover must be sown after the soja beans and with or after the corn to take up whatever fertility may be made available and to catch the energy of the sun that falls on these fields during the fall and spring of the year, either to be made into hay or plowed down when these fields are again prepared for corn and soja beans, or other legume.

The remainder of the farm, which would likely be about three-fourths of it, can be divided to raise crops, such as may be required to feed the animals. If dairying is the main operation, divide the remainder of the farm into two sections, raise corn on the one and clover either red and alsike or alfalfa on the other if this crop does well, all of them sown with the corn with an inter row seeder, sometime late in July or early in August. Other successions can be arranged for raising the crops needed. The silage and clover hay will furnish about all the roughage needed by the dairy and, therefore, a large part of the corn fodder after being shredded is used as absorbent for the excrement of the animals and applied directly from the stable on the clover and corn fields during the whole year. In an operation like this, animal products or animals are the only salable crops, everything else is returned to the soil and cannot do otherwise but increase its fertility. A still more simple succession of crop of corn and alfalfa may be practiced where only animal products are sold for human nutrition and where raising food for feeding these animals and maintaining the productiveness of the soil are essentials and where pasturing animals, especially hogs, may be desirable on account of not having all the labor that may be needed for attending to the feeding of all the animals and where they must, therefore be pastured.

The farm is divided into two fields, one for corn, the other for alfalfa. In this case the alfalfa must be sown with the corn some time late in July or early in August and the soil must be in the very best condition. In the southern, especially in the southeastern section of the State, the alfalfa can some seasons be sown after the corn is cut, but the soil must be fertile and in the best condition so that it will make a sufficient growth to winter well. The alfalfa should be allowed to occupy the soil for at least two years in succession and three years may be preferable and during these seasons a short season clover is sown with the corn every year and all the manure made on the farm during the fall, winter and early spring of these years applied to the corn land, which after the second or third year is sown with alfalfa as already indicated and the alfalfa field plowed up for corn and treated as previously described. This rotation is especially adapted for hog raising, because the hogs can be pastured on the alfalfa without injuring it and enough hay can be made afterward for all other stock, that can be kept on the farm beside the hogs as well as for the hogs. The corn is fed to the hogs to finish them, the corn fodder shredded some fed and the remainder used as absorbent for animal excrement and applied with the excrement on the field to be planted with corn. A little change in this rotation might be desirable and instead of growing corn on the whole half of the farm, part might be used for oats and barley for the hogs, but this will not change the general plan and principle. In this operation, all the manure goes back to the crops as it is made on the alfalfa, when the hogs are pasturing it and on the corn land directly from the stables and so do the grain feeds except what is used up by the animals in their body growth. It can readily be seen that this is a fertility raising rotation.

THE POTATO

The farmer is obliged to raise a number of crops demanded by the people, little of which can be returned to the soil, among these the potato is likely first in quantity. Usually these crops contain a low percentage of dry matter, as the potato, of which one thousand pounds or sixteen and *sixty-six hundredth bushels, contain 207.5 pounds or 20.75 per cent. dry matter. This amount of dry matter contains 3.10 pounds nitrogen, 1.3 pounds phosphoric acid and 4.8 pounds potash, therefore, a crop of two hundred bushel per acre or twelve thousand pounds would contain 37.2 pounds nitrogen, 15.6 pounds phosphoric acid and 57.6 pounds potash, and small amounts of other minerals such as lime and magnesia.

A succession of crops should certainly be arranged to supply the nitrogen for the potatoes and if possible bring potash within their reach, when minerals are disintegrating containing this element of

*Bulletin 15, Abtd.

fertility as is the case with Chloritic and Micaceous shist rock of the southeastern section of the State, most of which are adapted to potato growing. A rotation followed in some of the potato growing sections of the State is clover, after clover, potatoes and after potatoes wheat and then back to clover. This is a good rotation for the richer soils, but in the poorer soils it must be depleting unless large amounts of expensive fertilizer are applied. For this reason, it seems a rotation of clover than potatoes, followed by rye, and hairy vetch to which manure is applied, the vetch made into hay and fed to animals or plowed down and the land planted with corn and a short season clover crop sown with the corn and this plowed down and the ground planted with potatoes or one or several of the long season clovers can be sown with the corn as already described, a crop of hay raised and the clover sod plowed down for potatoes. In this case, the corn, clover, hay and corn fodder would be fed to animals, the manure largely used on the corn ground, so as to have no baneful effects on the potato crop. This rotation would furnish organic matter and nitrogen and only potash with a small amount of phosporic acid would likely have to be applied to keep up the productiveness of the soil.

CLIMATE OF PENNSYLVANIA AND ITS EFFECTS ON THE AGRICULTURE AND HORTICULTURE OF THE STATE

Fertility or the available plant food in the soil depends on the composition of the rock from which the soil is derived and results from the processes of disintegration together with such chemical changes in the composition of the mineral constituents as well as such processes of fermentation and decay of the organic matter as will make these soluble in water and upon the various processes by which toxic substances are rendered harmless or neutralized. The ideal amount of available plant food and water, free from all toxic substances or agencies would be such as would supply the growing plant with all the moisture and mineral matter it would need to store up all the available energy of the sun under the prevailing climatic conditions.

These climatic conditions vary in Pennsylvania as they do in all places with distances north of the equator with altitude or elevation above sea level, with distances from large bodies of water, with changes in temperature, with the amount of rainfall and the number of days during which the sun shines while the soil climate is influenced in connection with the conditions above enumerated, by the natural or artificial drainage, its friable condition and

the quantity of organic matter the soil contains as well as in its location whether on hillsides facing east and south or north and west or in valleys.

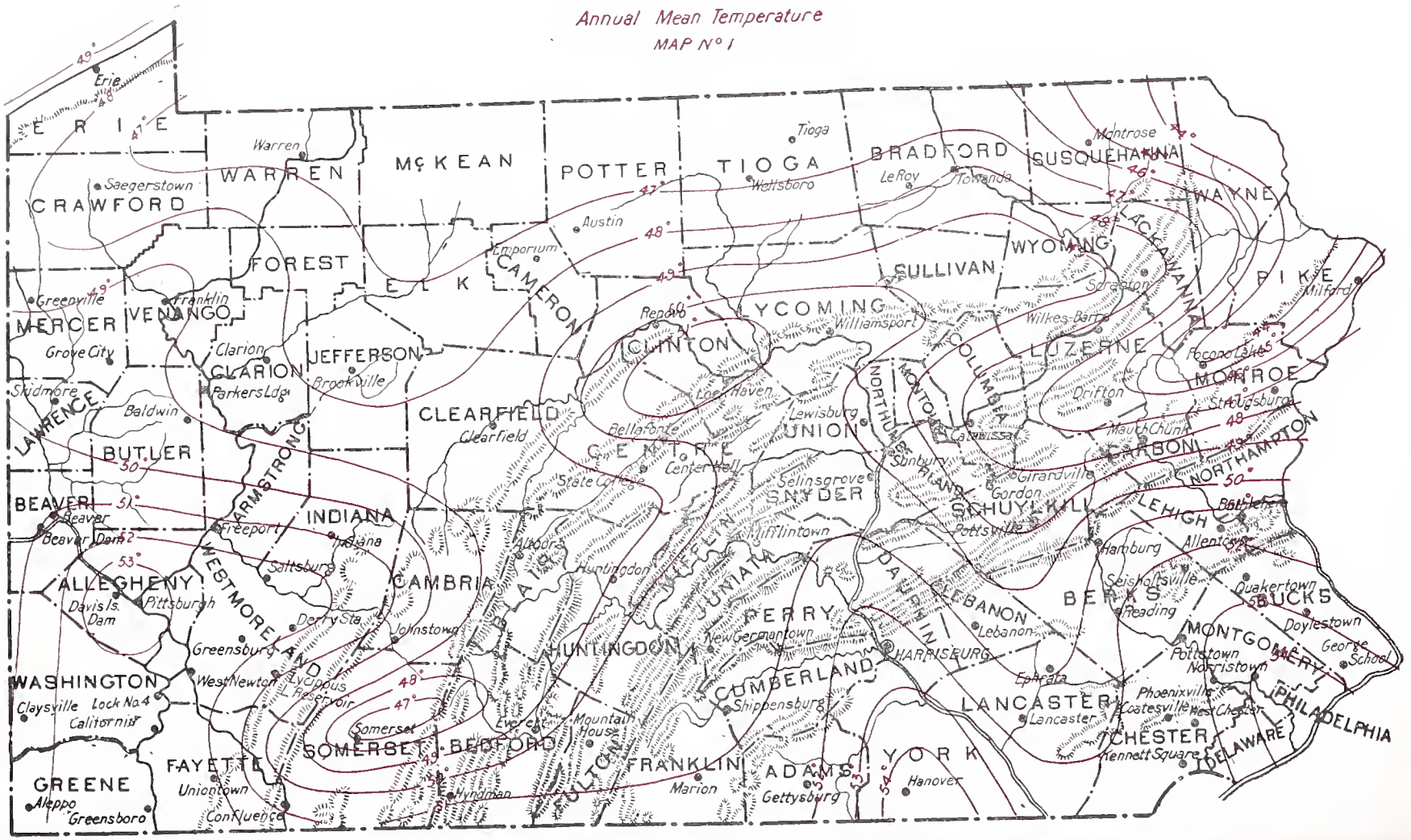
LATITUDE OF PENNSYLVANIA

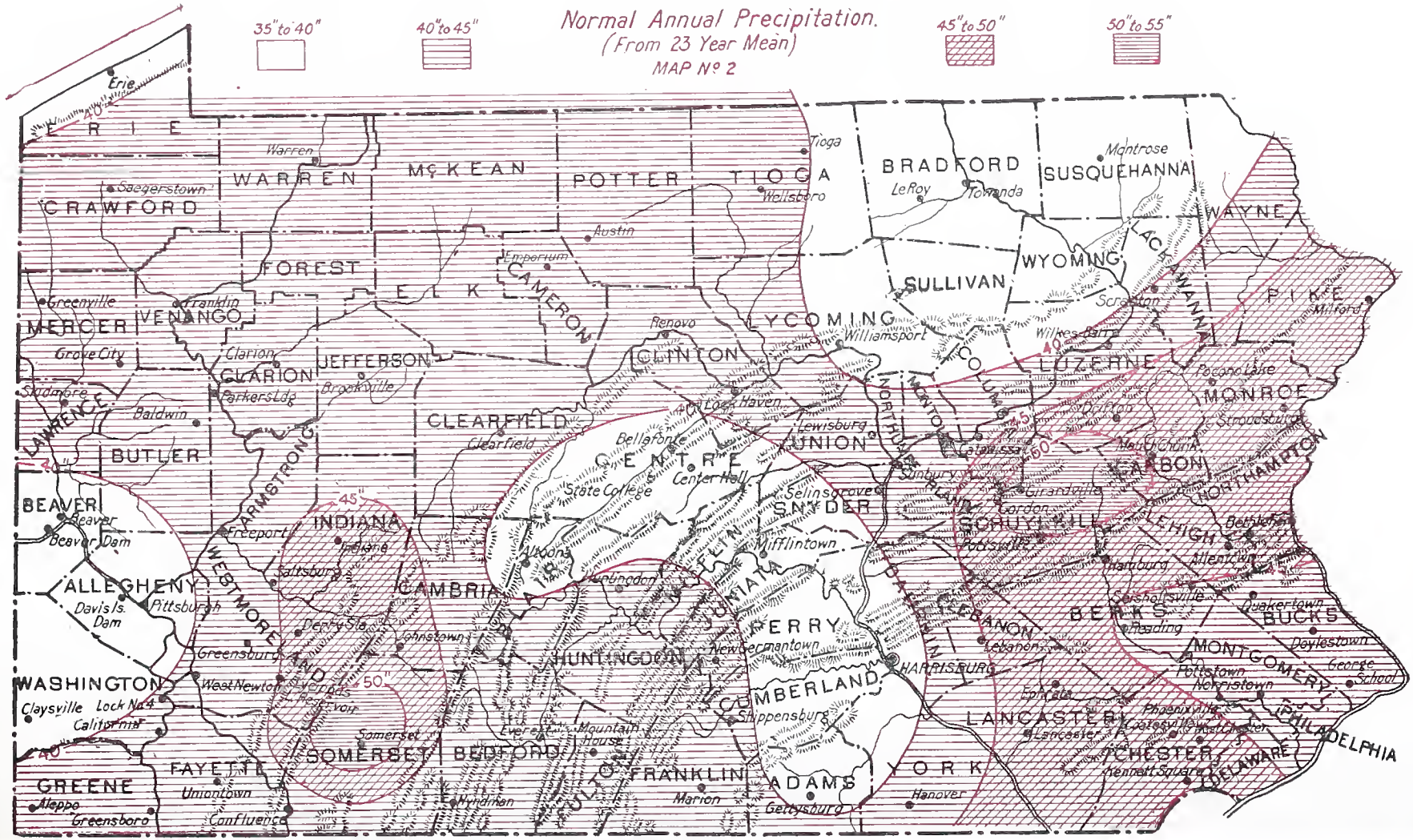
Pennsylvania has for its northern boundary the 42nd parallel of north latitude while its southern boundary lies a condsiderable distance south of the 40th parallel. The State extends an average of 302 miles westward from the Delaware River, its eastern boundary, and 175 miles north of Mason and Dixon's Line.

ANNUAL MEAN TEMPERATURE

The mean annual temperature of the State varies between 44 degrees in a limited area iu Wayne, Pike, Monroe and Susquehanna counties in the northeastern corner, and 54 degrees in limited areas in York, Montgomery and Delaware counties in the southeastern part, a difference in the mean annual temperature of 10 degrees in a distance of 175 miles, but a variation in elevation in Wayne county between 714 feet at Narrowsburg, on the Delaware River, and 2,040 feet in Mt. Pleasant township and 890 feet, at Foster, Lenox towuship and 2,023 at Ararat township, in Susquehanna county. In the areas throughout which the mean annual temperature or the lines of equal temperatures on Chart No. 1 rises to 54 degrees the altitude is less than 400 feet above tide while the area in which the mean annual temperature is 53 degrees though not so limited follows closely the areas of 54 degrees except a limited one in Allegheny and Washington counties, where the altitude is normally less than 500 feet.

The area of 52 degrees follows that of 53 degrees, but similar to the two previous areas, passes out of the State into Maryland and West Virginia and not until the area of a mean annual temperature of 51 degrees is reached, beginning in the northeastern corner of Lehigh county with an altitude of 235 feet and 75 miles from the southern border of the State and extending to Hamburg in Berks county at an elevation of 392 feet, where it curves southward along the Blue Mountain, thence south to Ephrata in Lancaster county, then northwestward to the northern part of Dauphin county at an elevation of 418 feet along the river, thence southwestward along the Blue Mountain which it ascends to an elevation of more than 1,000 feet near the southern border of Frauklin aud Fulton counties, continuing in a westerly by southwesterly course until it touches Mason aud Dixon's line along the highlands of Bedford and Somerset counties, reaching an elevation of 2,200 feet. After crossing Laurel Hill into Fayette county, it again changes northward along its western slope as far north as Blairsville, in Indiana county, at an elevation of 1,010 feet, thence westward to Freeport, in Armstrong county at an altitude of 770 feet and to Beaver, in Beaver county at an altitude of 710 feet from where it changes its western


Annual Mean Temperature
MAP N° 1
ERIE
MCKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
WARREN
CRAWFORD
FOREST
ELK
CAMERON
WYOMING
SULLIVAN
LACKAWANNA
PIKE
MERCER
VENANGO
CLINTON
LYCOMING
COLUMBIA
LUZERNE
MONROE
JEFFERSON
CLARION
LAWRENCE
CLEARFIELD
CENTRE
UNION
NORTHUMBERLAND
MONTOUR
CARBON
NORTHAMPTON
BUTLER
ARMSTRONG
SNYDER
SCHUYLKILL
LEHIGH
BEAVER
INDIANA
JUNIATA
PERRY
DAUPHIN
LEBANON
BERKS
BUCKS
ALLEGHENY
WESTMORELAND
CAMBRIA
BLAIR
HUNTINGDON
CUMBERLAND
HARRISBURG
MONTGOMERY
WASHINGTON
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
LANCASTER
CHESTER
PHILADELPHIA
DELAWARE
FAYETTE
GREENE
Erie
Warren
Saegerstown
Tioga
Wellsboro
Montrose
LeRoy
Towanda
Austin
Emporium
Greenville
Franklin
Grove City
Clarion
Parkers Ldg.
Brookville
Repaso
Williamsport
Scranton
Wilkes-Barre
Pocono Lake
Milford
Skidmore
Baldwin
Clearfield
Bellefonte
Lewisburg
Shinbury
Orifton
Mauch Chunk
Stroudsburg
Centerhall
State College
Selinsgrove
Girardville
Gordon
Pottsville
Bethlehem
Beaver
Beaver Dam
Freeport
Indiana
Saltsburg
Hamburg
Allentown
Seisholtsville
Quakertown
Doylestown
George School
Davis Is. Dam
Pittsburgh
Derry Sta.
Johnstown
Altoona
Huntingdon
Mifflintown
Reading
Lebanon
Greensburg
West Newton
Lycoming Reservoir
New Germantown
Shippensburg
Ephrata
Lancaster
Pottstown
Norristown
Phoenixville
Coatesville
West Chester
Claysville
Lock No. 4
Califonia
Somerset
Everett
Mountain House
Kennett Square
Uniontown
Confluence
Hyndman
Marion
Gettysburg
Hanover
Aleppo
Greensboro
49°
48°
47°
46°
50°
51°
52°
53°
54°


Normal Annual Precipitation.
(From 23 Year Mean)
MAP Nº 2
35" to 40"
40" to 45"
45" to 50"
50" to 55"
ERIE
Erie
CRAWFORD
Saegerstown
WARREN
Warren
MCKEAN
POTTER
TIOGA
Tioga
Wellsboro
BRADFORD
LeRoy
Towanda
SUSQUEHANNA
Montrose
WAYNE
Milford
PIKE
LACKAWANNA
Scranton
WYOMING
SULLIVAN
LYCOMING
Williamsport
Renovo
CLINTON
Lock Haven
LUZERNE
Wilkes-Barre
Pocono Lake
MONROE
Stroudsburg
CARBON
Mauch Chunk
NORTHAMPTON
Bethlehem
LEHIGH
Allentown
Harburg
Schuylkill Haven
SCHUYLKILL
Pottsville
Tamaqua
Girardville
Gordon
Sunbury
NORTHUMBERLAND
MONTOUR
Catawissa
Danville
Lewisburg
UNION
SNYDER
Selinsgrove
Mifflintown
JUNIATA
PERRY
New Germantown
Shippensburg
CUMBERLAND
HARRISBURG
DAUPHIN
LEBANON
Lebanon
BERKS
Reading
Schoolsville
Quakertown
BUCKS
Doylestown
George School
MONTGOMERY
Pottstown
Norristown
PHILADELPHIA
DELAWARE
CHESTER
Kennett Square
LANCASTER
Lancaster
Ephrata
Phoenixville
Coatesville
West Chester
YORK
Hanover
ADAMS
Gettysburg
FRANKLIN
Marion
Mercersburg
FULTON
BEDFORD
Everett
Mountain House
SOMERSET
Somerset
FAYETTE
Uniontown
Confluence
GREENE
Aleppo
Greensboro
WASHINGTON
Claysville
Lock No 4
California
ALLEGHENY
Pittsburgh
Davis Is. Dam
BEAVER
Beaver
Beaver Dam
LAWRENCE
Slippery Rock
Baldwin
BUTLER
Freeport
ARMSTRONG
Kittanning
INDIANA
Indiana
Saltsburg
WESTMORELAND
Derry Sta.
Greensburg
West Newton
Port Vue
CAMBRIA
Johnstown
Ebensburg
CENTRE
Bellefonte
State College
Center Hall
Philipsburg
CLEARFIELD
Clearfield
JEFFERSON
Brookville
CLARION
Parkers Ldg.
Clarion
VENANGO
Franklin
Oil City
MERCER
Grove City
Greenville
ELK
Emporium
CAMERON
Austin
FOREST

to a southern course until it reaches the southwestern corner of Greene county and passes out of the State, illustrating in a remarkable manner, the effects of altitude, and to a certain extent, that of latitude on the mean annual temperature of these various sections of the State.

As above indicated, the effects of altitude are remarkably illustrated in this State. Montgomery, Delaware and York counties, with an altitude of less than 400 feet, approximately in the same latitude as Somerset, the former places having a mean annual temperature of 54 degrees while the latter, with an elevation of 2,200 to 2,300 feet, has a mean annual temperature of 47 degrees, a difference of 7 degrees or one degree for about every 300 feet, putting this section into the same agricultural zone as Bradford, Tioga, Potter, McKean, Warren, parts of Crawford and Erie counties, 175 miles further north.

The 49th and 50th degree isotherm or equal temperatures lines, illustrate still further these same effects and embrace the most extensive area of any in the State. They begin in the northeastern and central parts of Northampton county, at an altitude of 600 to 700 feet, crosses the Blue Mountain into Carbon and Schuylkill counties, then northwestward through Northumberland and the central part of Montour, at an altitude of 489 feet, then northeastward through northern Columbia and Luzerne to the southeastern corner of Wyoming county, at an altitude of 587 feet, thence northwestward to the northwestern part of Wyoming, thence westward through southern Sullivan and Lycoming at an altitude of from 530 to 760 feet, thence southward and eastward into Clinton at an altitude of 560 feet at Lock Haven, then southward and eastward to Mifflin county at an altitude of 525 feet, then southwestward through Huntingdon, west of Everett in Bedford county, from where they change southwestward, cross the mountain into and to the western border of Somerset county, south of Somerset at an altitude of 1,800 feet within fifteen miles of Mason and Dixon's line, from where they change their course northeastward into the central part of Cambria county, thence northwestward through southwestern Clearfield, northern and central Indiana and Armstrong into Butler county where the 49th degree isotherm changes northward to some distance north of Franklin in Venango county, and thence westward through central Mercer into the State of Ohio, while the 50 degree extends westward through Lawrence county into Ohio. The influence of latitude on the mean annual temperature is no where strikingly illustrated in Pennsylvania; but its effects are shown along the Susquehanna River, at an altitude of less than four hundred feet at York where the mean annual temperature is 54 degrees and in central Clinton county, 175 miles further north, where the mean annual temperature

is 51 degrees, at an elevation of 500 feet. Allowing for one degree of lower temperature for elevation, there is an approximate difference of two degrees, which is accounted for by latitude showing that a few hundred feet in elevation will frequently produce as great a change in temperature as several hundred miles of latitude.

INFLUENCE OF LARGE BODIES OF WATER ON TEMPERATURE

Not only does the same mean annual temperature as previously given extend close to the northern border of the State and approximately to the southern in Somerset county, illustrating how altitude mitigates the effects of latitude, but it also happens to be the prevailing mean annual temperature along the shores of Lake Erie more than one hundred miles further north than the northern limits of Lehigh county at an elevation of 573 feet, and the northern limits of the area reached in Sullivan county at an altitude of 530 to 700 feet above tide and that reached in Mercer county, at an altitude of 900 feet, demonstrating the effects of large bodies of water on the temperature of a county. Certainly the somewhat lower altitude of Lake Erie accounts for the lower mean annual temperature, but at least two degrees are due to the effects of the water in Lake Erie. The moderating influence of large bodies of water on the climatic conditions of the country bordering it, especially along the ocean making the climate warmer in winter and cooler in summer is due to two causes: That of its large heat absorbing and heat holding capacity and to the fact that fully half the heat falling upon the surface of water is used up in changing a certain quantity of the liquid into a vapor and consequently the heat so used is held in a latend condition and the temperature of the air on the surface of and surrounding the body of water is reduced until the vaporized water is again changed into a liquid or solid and fall as rain or snow when the latent heat again becomes appreciable. The heat not used up in the vaporization of water penetrates the water and raises its temperature to a depth of thirty feet during a single day while during the entire summer season the temperature of water is raised to a depth of 500 feet whereas that of the soil is not effected to a depth of fifty feet. Because of this larger storing of heat in water than in the soil and the tendency of the soil to cool more readily or giving up heat more easily than water the temperature of the soil and air in a short time equalizes while the temperature of water which is so much larger requires a longer time and therefore continues for a longer time to give up heat, all of which is manifest by even so small a body of water as Lake Erie and, therefore, instead of the mean annual temperature being what it would normally be at this latitude and altitude, is about two degrees higher.

PRECIPITATION

As previously stated, fully one-half of the heat falling on a surface of water was used in changing the liquid into a vapor. This vaporized or gaseous water exists in the air or is suspended in the air and the warmer the air the greater its capacity for holding water vapor so that air at 60 degrees has three times as great water vapor holding capacity as air at 0 while air at 100 degrees has fifteen times as great a water holding capacity as air at 0°. The amount of water vapor that can exist at any time in the air depends on its temperature and therefore all the factors previously referred to such as latitude, altitude and the presence of large bodies of water which lower and raise the temperature of the air have a marked effect on the precipitation or rain and snow fall of any county.

ALTITUDE AND PRECIPITATION

The effects of altitude on precipitation are well illustrated in Pennsylvania. Somerset county, lying on the western slope of the Allegheny Mountain, contains the highest land in the southern section of the State. The moisture laden warm wind coming from the southwest from whence most of the cyclonic storms which bring the rains throughout this region come, strike these highlands, are cooled down and give up their moisture in rain and snow which, according to Figure 2, giving the annual normal precipitation for the last twenty-three years amounts to from 50 to 55 inches in this section, while in all directions it becomes less. Northward along these highlands to the central part of Indiana county the annual precipitation keeps to from 45 to 50 inches. Directly northeast and east of these areas and largely east of the Allegheny Mountains in Blair, northeastern Huntingdon, Center, northeastern Mifflin and Juniata, the greater part of Perry, eastern Cumberland and nearly the whole of Adams and a small area of western York. after the cyclones coming from the southwest have passed over the highlands of Bedford, Fulton, southern Huntingdon, Mifflin and Juniata where the precipitation ranges from 40 to 45 inches when they reach the low altitude of the Cumberland Valley and the slopes of the South Mountain, but especially the plains of Adams county where, because of soil formation, the air is warmer and consequently holds more moisture, the precipitation is less and ranges only from 35 to 40 inches or from 5 to 20 inches less than on the high elevations previously enumerated.

Another area of precipitation ranging from 45 to 50 inches occurs in the eastern and southeastern part of the State covering the southeastern part of York, the greater part of Lancaster, nearly all of Chester and Delaware, extending northward over Lebanon, the greater part of Berks, all of Lehigh and Northampton, across the

Blue Mountain into Schuylkill county, where the precipitation rises to from 50 to 55 inches which is also partly due to the high elevations along the northern border of this county. At Long Pond in southeastern Sullivan county the altitude reaches 2,200 feet above tide but also to the recurve of the coastal storm from which the increased precipitation of this southeastern part of the State are derived which covers the whole area except Bucks, Montgomery, Philadelphia, northern Delaware, eastern Chester and Berks where the precipitation ranges from 40 to 45 inches, likely due to the decreased snows of the winter and the decreased rain fall of mid-summer caused by the great heat reflecting soils of Mesozoic derivation and because the elevation is less than two hundred feet in much of this area.

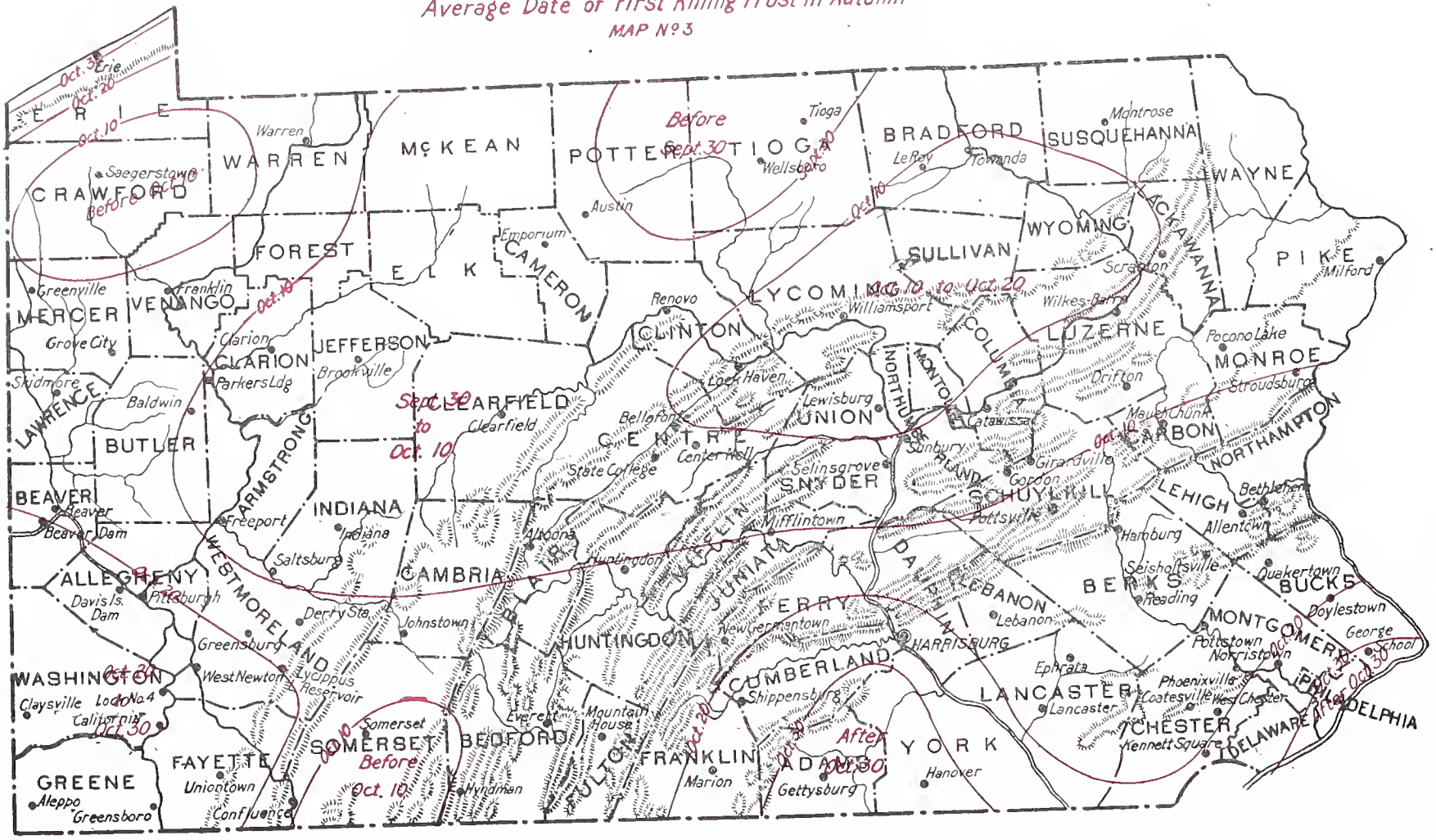
Northern Wayne, northern Lackawanna, northern Luzerne, northern Columbia, Montour and Northumberland, central and eastern Lycoming, eastern Tioga, all of Bradford, Susquehanna, Wyoming, and Sullivan counties compose another area in which the precipitation ranges from 35 to 40 inches which is partly due to the mountain barriers running northeastward through Columbia, Luzerne, Lackawanna into Wayne county which the coastal storms for some reason do not cross and which when the Ohio valley storms reach this section they have warmed to such an extent that they can contain more moisture which, together with this less elevated locality, accounts for decreased precipitation throughout this area and demonstrates both the effects of less elevated sections on cyclonic storm and precipitation.

WEATHER

Weather is the term used to express the changes in temperature or heat and cold, the changes from dry to wet, or rainy weather, clear or sunshiny to cloudy and humid weather, any or all of which may occur from day to day. It must be evident to all who have studied the subject of weather that it modifies the general effects of latitude, altitude and large bodies of water and is a factor in determining the climatic conditions of any area or country. These changes in the weather are produced by the changes in the direction of air movements or the motion of the air. The air movements are always toward areas of low pressure, that is where the air becomes lighter and begins to rise, and as this tendency becomes intensified, air from all directions flows toward this general center of low pressure, from which the air rises as an enormous column from whence it spreads out in counter currents in the upper atmosphere. Some of these low pressure areas toward which the air moves and which develop into cyclonic storms originate in the Pacific Ocean, others in the northwestern part of this country while others begin in the southwest. Usually the storms that originate in the northwest move

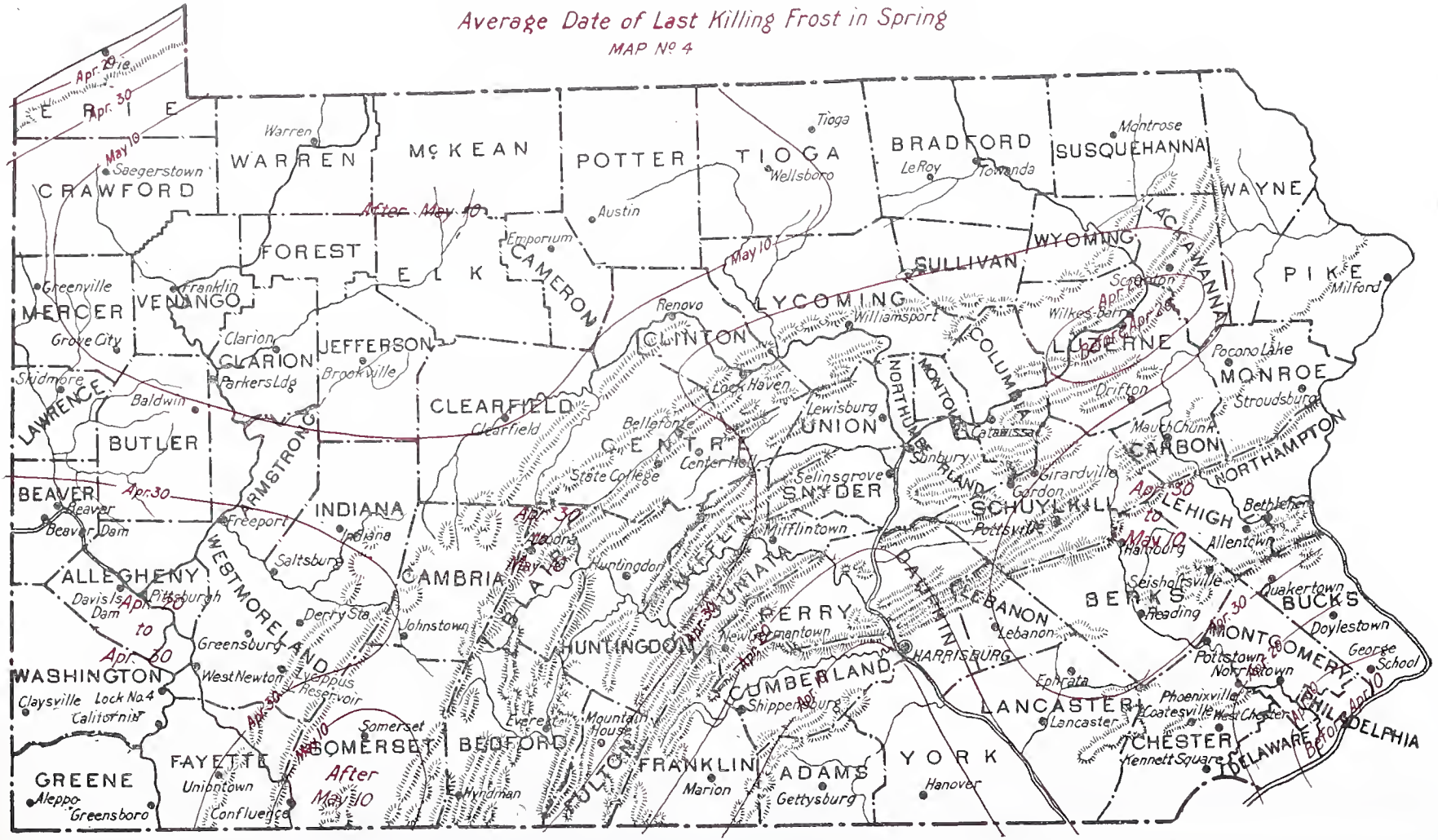
Average Date of First Killing Frost in Autumn

MAP No. 3



Average Date of Last Killing Frost in Spring

MAP No 4



in an easterly direction over the northern United States or Southern Canada over the Great Lakes and down the valley of the St. Lawrence. Sometimes northern and western Pennsylvania receives some of the rain from these storms, but the greater part comes to the western part of this State from the storms which originate in the southwest and move eastward and northeastward across the United States,

As previously stated the air moves toward the area of low pressure from all directions. The currents coming from the south and southeast in Pennsylvania are warm and moisture laden and, as previously indicated, warm air has a greater moisture holding capacity than cold air, therefore, when these warm moisture laden currents coming from these directions strike the colder air currents coming from the north they become chilled and clouds are formed and in the onward movements of the air more chilling occurs and rain begins to fall and by the eastward movement of the cyclone new territory is invaded and a continuous supply of moisture is furnished by the inflowing southern air and cloudy and rainy weather prevails. On account of the spiral motion of the eastward moving cyclone the course of the winds move round to the east or even to the northeast of the low pressure area until they are cooled sufficiently to cause precipitation and the area of continuous rain or snow fall are east or northeast of the low pressure. As previously indicated, the universal movements of air currents toward the area of low barometric pressure brings the cold winds of the north down into this area and as these currents in coming in contact and mixing with the warmer current are warmed and their moisture holding capacity increased and any clouds they may contain are dissipated in consequence of which the air currents coming from the north which because of the eastward spiral movements of the cyclone are changed to the northwest winds cause clear and colder weather to follow the cyclone, while that which preceeded the storm was warm sometimes sultry in summer time, cloudy and rainy. Not only do these cyclones bring rain and changes in temperature, but there is an occasional tendency for these storms to follow in the wake of the preceeding storms and in the region north of the central path of the cyclone during such seasons will have an unusually large rainfall while the region south of the path will have a very light rainfall and in this way they become the agencies of producing wet and dry seasons in certain sections of the State especially in those sections in which the precipitation is the lightest and because of which crop yields are not up to what they would have been had there been more precipitation. Especially is this true of the southeastern section.

But while a deficient supply of moisture will limit crop yields, yet usually heavy rainfall throughout the growing season will frequently

produce a lowering of the temperature, especially in the northern part of the State and on the higher elevations, that there may be frosts during any month of the year except July and August and such hot weather crops as corn, and the soja bean, the cow pea and others can not thrive though the moisture supply be abundant.

The late frosts in the spring and the early frosts in the fall, which shorten the growing season that such crops as corn, the legumes above referred to and potatoes can not ripen, usually follows these cyclonic storms, accompanied with a heavy rainfall. But not only do these storms prevent agricultural crops from getting an early start or ripening, but when they come along during the blossoming season of the fruit trees an entire season's crops may be destroyed in one night by frosts, especially in low places.

FROST AND AIR DRAINAGE

The cold air coming from the north and the northwest following these cyclonic storms becomes slightly warmer as it moves southward and acquires a larger water holding capacity, and, therefore, takes up from the soil some of the moisture from the previous rains and chills it, while at the same time the soil looses heat by radiation during the day as well as through the clear air on still nights and in this way the soil becomes cooler than the air immediately above it, and in consequence this lower stratum of air gives up heat to the soil by conduction and becomes colder and denser or heavier than the air a little distance above this lower stratum and, therefore, if this cooling occurs on an incline, the cooler and heavier air will flow down the slope and collect in hollows or valleys which will become gradually filled with colder and denser air in consequence of which late spring and early fall frosts occur much more frequently in valleys and hollows than on the higher slopes because as the denser air creeps down the hillsides, the warmer air from the higher elevations and higher and warmer layers is drawn down to the soil.

This process is known as air drainage and should be so thoroughly understood by the farmers in the various sections of the State so that wherever on a farm such areas exist, crops sensitive to frost should not be planted. Especially is this the case with fruit trees. As previously indicated, the cooling of the lower stratum of air is caused by radiation from the cooler soil, and in consequence, the water vapor holding capacity of this lower layer of air is diminished and dew is deposited, and if the ground is covered with a sod or any organic matter which radiates heat more rapidly than it receives it by conduction from the soil beneath and in this way making a temperature anywhere from 8 to 15 degrees lower; depending on the locality and the humidity of the air; immediately over the sod and

that on the surface of the bare ground a difference sufficient to cause a severe frost in the sod field or a field planted with vegetables and no frost at all on the bare ground.

As previously indicated, altitude and the distribution of land and water are the great factors that determine the climatic conditions of a region such as the annual mean temperature, the seasonal temperatures and to a certain extent the annual precipitation, the cyclonic storms act as modifiers of these general effects in such a way as in many places to determine the average length of the dates between killing frosts in the spring and the fall the average dates of which are given, in the following two charts.

THE GROWING SEASON

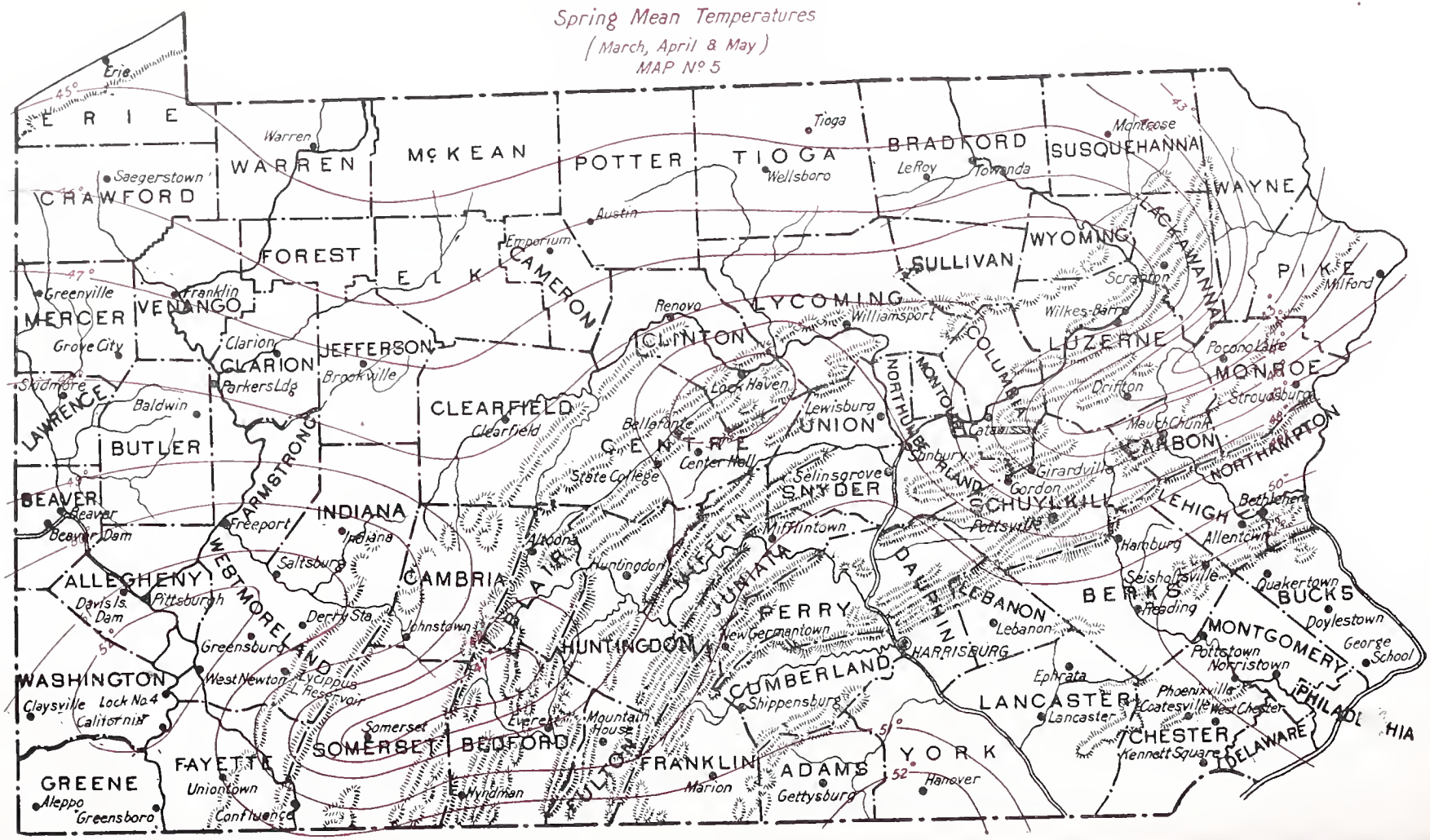
The average date for a number of years of the last killing frost in the spring and the first killing frost in the fall limits the growing season for any section of country of such crops as corn, potatoes and such clovers as the soja bean, the cow pea, the Canada field pea while such crops as fall sown wheat, rye and winter oats as well as red and alsike clovers and timothy and such root crops as rape and turnips will go on growing until the ground and plant juices freeze. The average date of the last killing frost in the spring chart No. 3 varies from before April 10 in eastern Bucks, Montgomery, Philadelphia and northern Delaware counties, and after May 10th, in Somerset, Clearfield, Jefferson, Clarion, Venango, Warren, McKean, Cameron, Elk and limited areas of adjoining counties, while the average dates of the first killing frosts in the fall according to chart No. 5, varies from after October 30, in eastern Bucks, Montgomery, Philadelphia and northern Delaware and nearly all of York and Adams counties in the southeastern and southern parts of the State and before October 10th in Somerset, Crawford, western Warren and northern Venango.

The shortest average growing season, therefore, extends over four months, or 150 days, while the longest ranges from before April 10th, about Philadelphia and York until after October 30, in the same vicinities or, approximately, 200 days. Besides these differences in the length of the growing season or the time between killing frosts, there is such a difference in the seasonal temperature as will interfere with the successful raising of a considerable number of crops so that a rotation of such crops should be adopted for the various sections of the State as will yield the largest returns in human nutrition and at the same time improve the soil. The season between killing frosts is sufficiently long throughout the entire State to grow and ripen the various varieties of dent corns; but the seasonal temperatures are such on the higher elevations of the Allegheny

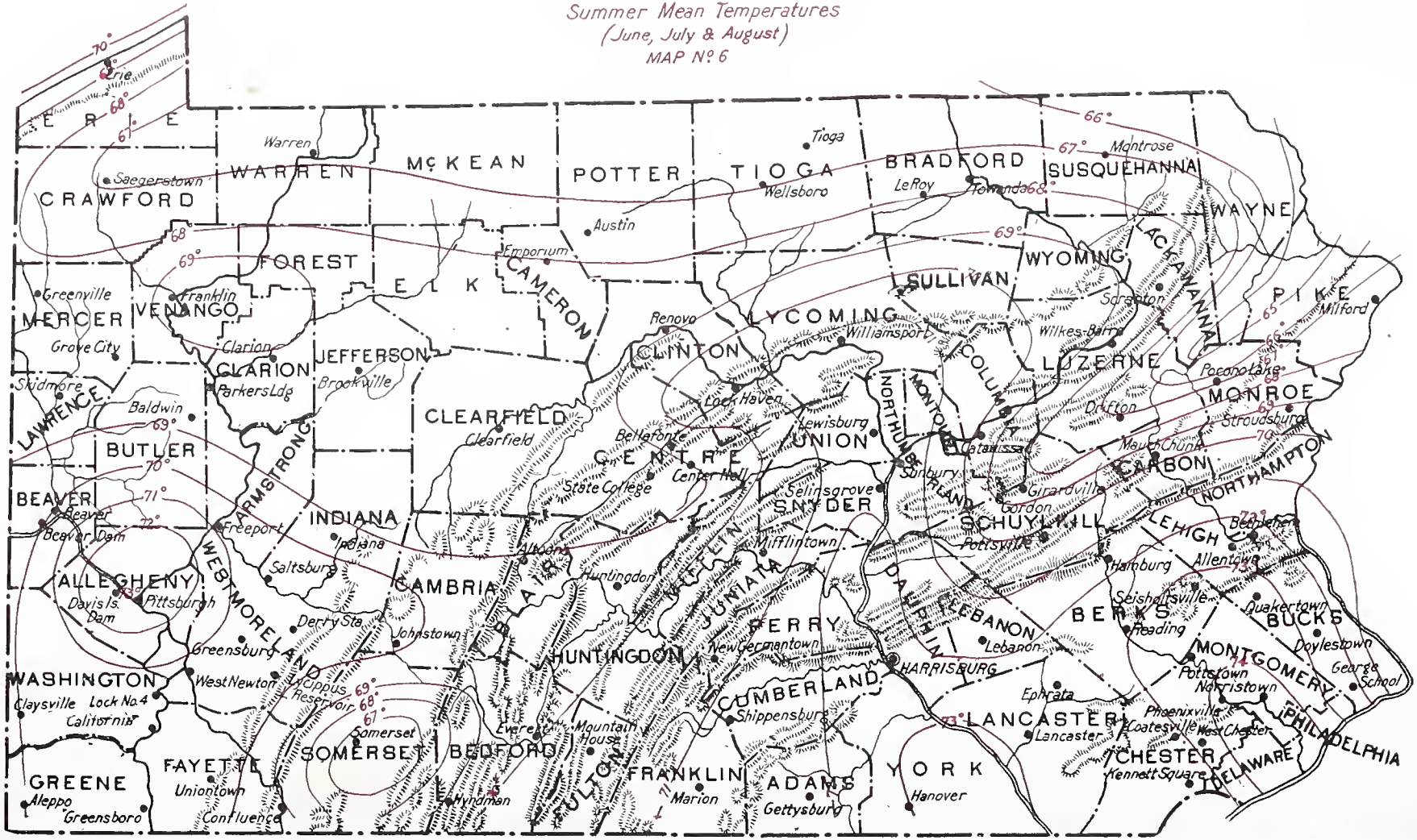
plateau and in the northern tier of counties that the highly developed flint varieties of corn for grain and the more luxuriant stalk producing varieties for silage yield the more satisfactory returns.

MEAN SPRING TEMPERATURE

Map No. 5 gives mean spring temperature for the various sections of the State. Nowhere throughout the whole State does the average temperature fall below that required for fall sown plants such as wheat, rye the hay grasses and such clovers as red, alsike, crimson and the winter vetch and alfalfa to begin their growth, or the spring sown cool weather cereals such as oats, spring wheat, barley, spelts and others, and among the legumes, the Canada field pea to germinate and grow. On the higher elevations and in the northern tier of counties, March may be included with the winter months, because seldom can any agricultural operations be started anywhere north of the 48th degree area of temperatures before April or the middle of April, while in the southern part of the State, except on the Allegheny plateau or south of the 50th degree area of temperatures, cultivation can begin in March especially on the soils derived from the Hudson River shales and slates some of the Clinton, Salina and Chemung shales and slates which are not injured by being cultivated wet and are sufficiently warm for (the cool weather crops previously enumerated to which potatoes may be added) crops to germinate and usually keep on growing. Wherever such soil and climatic conditions prevail either fall sown cool weather cereals such as rye and winter wheat and cool weather legumes such as winter vetch and crimson clover among the short season and red and mammoth clovers among the perennials and early potatoes should be raised as well as oats and wherever possible the Canada field peas so as to get the benefit of the moisture derived from the snows and that from the excess of precipitation during the spring and develop a crop before the hot and dry weather of July and August comes and stops the development of these crops. In the southeastern and southwestern sections of the State, unless oats and Canada field peas are sown in March or before the middle of April, which is frequently possible on the gravelly or sandy loams of the rolling uplands throughout these sections so that they make their growth during the spring and early summer months, the peas frequently do not produce seed and the oats is light in weight except when the latter part of June and early July are abnormally cool, while oats, barley and spelts among the cereals and Canada field peas sown a month later in the northern section will, because of the cooler climate, invariably make larger yields of heavier and more highly developed seed. Wheat, which developes its grain and ripens it largely during the month of June in this southern section, is heavier than wheat that developes its


Spring Mean Temperatures
(March, April & May)
MAP No. 5
ERIE
MCKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
WARREN
CRAWFORD
FOREST
ELK
CAMERON
SULLIVAN
WYOMING
LACKAWANNA
PIKE
MERCER
VENANGO
CLINTON
LYCOMING
COLUMBIA
LUZERNE
MONROE
CLARION
JEFFERSON
LAWRENCE
BUTLER
ARMSTRONG
CLEARFIELD
CENTRE
UNION
NORTHUMBERLAND
MONTOUR
CARBON
NORTHAMPTON
BEAVER
INDIANA
SNYDER
SCHUYLKILL
LEHIGH
ALLEGHENY
WESTMORELAND
CAMBRIA
JUNIATA
PERRY
DAUPHIN
LEBANON
BERKS
BUCKS
WASHINGTON
HUNTINGDON
CUMBERLAND
HARRISBURG
MONTGOMERY
PHILADELPHIA
FAYETTE
SOMERSET
BEDFORD
FRANKLIN
ADAMS
YORK
LANCASTER
CHESTER
DELAWARE
GREENE
Erie
Warren
Tioga
Montrose
Saegerstown
Wellsboro
LeRoy
Towanda
Austin
Emporium
Scranton
Milford
Greenville
Franklin
Renovo
Williamsport
Wilkes-Barre
Grove City
Clarion
Brookville
Pocono Lake
Skidmore
Parkers Ldg
Lock Haven
Drifton
Stroudsburg
Baldwin
Clearfield
Bellefonte
Lewisburg
Mauch Chunk
Center Hall
Sunbury
Girardville
Beaver
Beaver Dam
Freeport
Indiana
State College
Selinsgrove
Gordon
Bethlehem
Pottsville
Allentown
Altoona
Mifflintown
Harrisburg
Saltsburg
Huntingdon
Seisholtzville
Quakertown
Davis Is. Dam
Pittsburgh
Derry Sta.
Johnstown
Reading
Doylestown
Lebanon
Greensburg
New Germantown
Pottstown
George School
Norristown
Claysville
Lock No. 4
West Newton
Lyuppus Reservoir
Ephrata
Phoenixville
Shippensburg
Coatesville
West Chester
Somerset
Everett
Mountain House
Lancaster
Kennett Square
Aleppo
Uniontown
Myndman
Marion
Gettysburg
Hanover
Greensboro
Confluence

Summer Mean Temperatures
(June, July & August)
MAP No. 6



grain during the latter part of June and ripens it in July, while wheat developed and ripened during July in the northern or higher and cooler sections of the State is equally as heavy and yields as well as in the southern section while in what might be termed the transitional areas in which the mean spring temperatures range from 50 degrees down to 48 degrees the developing and ripening season for the cereals such as wheat, rye, oats and barley and the cool weather clovers should wherever soils are adapted for raising these crops be the most perfect.

SUMMER MEAN TEMPERATURE

Map No. 6 gives the summer mean temperature or that of June, July and August. All the temperature areas from 74 degrees down to 69 degrees pass out of the State to the southeast or south except a small area in Washington, Allegheny and Westmoreland counties where the areas of 71, 72 and 73 degrees are confined to a limited section. The summer mean temperature areas of 70 degrees extends from east of the Allegheny Mountain in Bedford county as far north as Clinton, Lycoming, Sullivan, Wyoming, western Luzerne, Columbia, Montour, Northumberland, Union, Snyder, through Schuylkill, Carbon and northern Northampton into New Jersey, while the same temperature area west of the Allegheny embraces all of Greene, Fayette, eastern Westmoreland, southern Armstrong and Butler, eastern Beaver and all of Washington except the northeastern part. In the center of this latter area the summer temperature rises to a mean of 73 degrees. These areas of higher temperatures are confined largely to the areas of the lowest precipitation. This is especially true of the Pittsburg area. The area between the 69 degrees and 68 degrees equal temperature lines or summer isotherms are the normal-limits in which any but the ninety to a hundred day varieties of dent corn can be ripened and therefore the large yielding, highly developed flint varieties should be raised for grain and the large roughage or silage producing varieties for silage. A rotation of crops should be arranged in such a way as to avoid raising corn in the hollows or in such localities where frosts are likely to occur after the cyclonic storms and so limit the growing season so that corn will not ripen.

What has been said under the discussion of spring mean temperatures in the northern and higher elevations and their adaptation for starting the growth of fall sown cool weather cereals and leguminous crops as well as for sowing and planting the cool weather spring crops such as oats and barley and the Canada field pea and potatoes and their adaptation for starting these crops is true of the adaptation of the summer mean temperature for developing and ripening summer crops. Rye is one of the fall sown, cool weather cereals which seems

to thrive especially well and yield large crops wherever soil conditions are right, along the areas from the 69 degrees down to 67 degrees isotherms, and is one of the cereals which it seems should be more largely raised because for its adaptation as a feed for horses and its high feeding value. But oats is without question the best adapted cereal for these northern and higher elevated areas, and wherever this cereal yields from 50 to 70 bushels per acre it should occupy the leading position in the rotation, and where the Canada field pea and oats can be grown together to ripen for grain or to be made into hay so that a soil improving crop could be raised with oats the soil exhausting crop, this should be done both for the benefit of the soil and the splendid grain and roughage feed such a combination makes. The small cereal grains, the grasses and clovers grown for seed in the northern part of the State have strong vitality which is due to the climatic conditions under which they ripen. The areas throughout which the summer mean temperatures fall below 67 degrees, which is very limited in Pennsylvania, is well adapted for raising the pasture and hay grasses as well as oats and Canada field peas, and wherever the soils are derived from the Catskill red shales, winter wheat, and it seems to the writer, spring wheat should yield paying returns.

According to those who have studied the question, the summer mean temperature areas below 67 degrees come within the summer temperatures best adapted for cheese dairying which has been in the past a more extensive industry than at present but which because of the development of varieties of large silage yielding corn and the possibility of storing large quantities of a highly nutritious and succulent roughage by means of which with a grain ration of oats and Canada field peas which can be produced here or by the purchase of highly nutritious by product feeding stuffs at such prices as to yield paying returns, the more ready cash returning butter and milk dairy has displaced the cheese dairy even throughout this climatically adapted district. While butter and milk dairying has displaced cheese dairying in the climatically adapted cheese dairying areas, milk dairying has invaded the butter dairy district and is threatening to displace it because of the demand for milk by the large cities within reach of these districts and because as much or even more can be realized for the milk with less efficient labor and with less labor. The area north of 70th degree equal temperature line should because of the somewhat climatically limited crop, accommodating and producing capacity be devoted to butter dairying, the butter milk fed to hogs or calves and the butter, the hogs and the baby beef made the money crop and all the excrement together with the straw and the soil improving crops returned to the soil so as to maintain its fertility. Throughout this area, more especially in the southern part, the 110

day varieties of Dent corn will ripen and with careful seed selection and cultivation and by raising such soil improving crops as crimson clover, vetch, red, alsike, Mammoth and sweet clover and alfalfa the yield of this crop can be made twice as large as they now are throughout this region. In the northern part of this area as previously indicated a highly developed flint corn could likely produce large yields. The southern area or the area including the summer equal mean temperature lines of 70 degrees and above embraces all the southern counties except Somerset and extends from Bedford county northeastward into Clinton, Lycoming and Sullivan and includes all the counties south of these in the eastern central section and all south of the southern part of Schuylkill and Carbon and south of Monroe, and in the southwestern section, the area includes all of Greene, Fayette, Westmoreland, Allegheny, and Washington and small areas of several adjoining counties.

Throughout this area, except a small section, including Northampton and Lehigh and Berks counties, the average date of the last killing frost in the spring comes before April 30, and the first killing frost in the fall, October 10th, and after that date, making the season between killing frosts from 150 to 175 days in the northern section and from 175 to 200 days in the southern but especially the southeastern which with a summer mean temperature of 70 degrees and above makes this whole area climatically and wherever the soils are derived from the limestone, the shaly limestone, the micaceous exposures, the limy Clinton shales, the Salina limy shales, the Lower Helderberg limestone, the limy Marcellus with a few areas of the Chemungs, agriculturally one of the best corn growing sections in the United States. The northern and central sections of this area as has been intimated under the discussion of spring mean temperatures are climatically splendidly adapted for wheat raising, which is true of the southern section when the early ripening varieties are raised because these will develop and ripen largely before the hot weather for corn making begins. But corn is the most valuable cereal that is being grown throughout this area and should, therefore, occupy the position of advantage in the rotation.

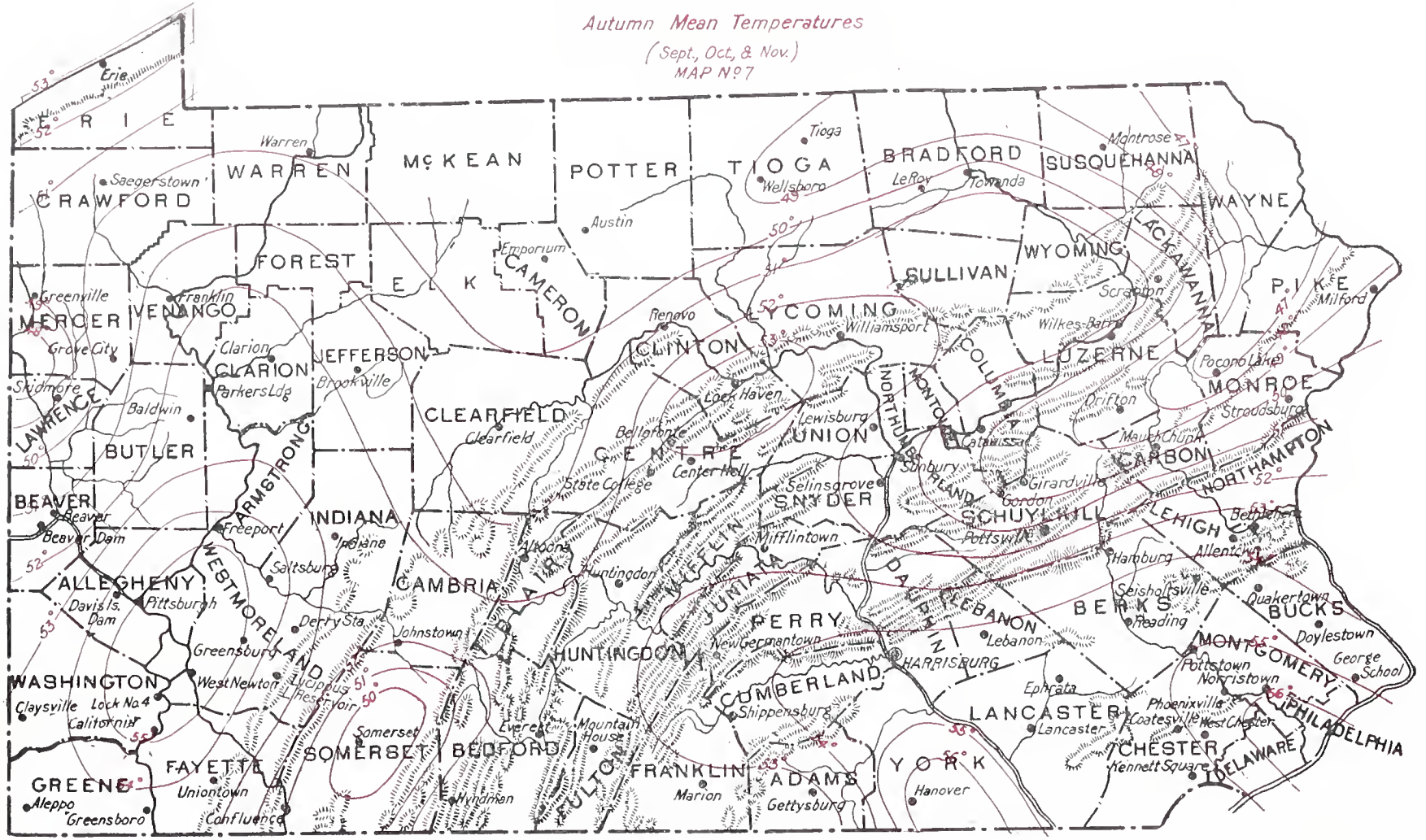
Wherever the farm manures are applied on the grass sod, the fertility contained in this manure is made available gradually and built up into the roots, stems and leaves of the grasses and clovers that should make up the sod, and when the sod is plowed up and the agencies of decay are assisted in their operations of making available the fertility contained in the sod, by intensive cultivation, especially of the loamy and clayey soils, before and after planting the corn, and corn in addition being a coarse feeder makes this the advantageous position in the rotation for this crop. With types of Dent corn developed and adapted so that they will take up the entire

corn growing and ripening periods for the various climatic and soil conditions of the various sections of this area, yields of corn can be increased to approximately twice what they now are. Another thing that can readily be done throughout these areas and should be done throughout the whole State is, that a growing crop can be maintained on the land at all times.

Just what these crops should be whether a legume or not depends on the rotation, its purposes and the location in the area. The rotation of crops grass, corn, oats and wheat and then back to grass now followed throughout this whole area, except in the southern part where oats have not been yielding satisfactory returns, wheat has been and is now being sown in the corn fields after the corn has been harvested usually without plowing the corn stubble and this wheat is followed with wheat and then with grass. The prevailing opinion among farmers throughout the area in which corn is followed with oats and which is a very desirable crop, is that it does not pay to sow any of the legumes with the corn after the corn has developed to such an extent that it is no longer benefited by cultivation.

This opinion is certainly not founded on practical experience and, therefore, may or may not be correct; but whether correct or not it does not preclude the necessity and the possibility of having a growing crop on the soil at all times. Therefore if some of the legumes can not be raised, certainly other crops such as rape, the cow horn turnip or some other of the turnip family which will grow long after the first killing frost and will take up and hold the fertility made available after the corn no longer needs it as well as add large quantities of organic matter to the soil, can be raised. If, in connection with these crops, a clover is raised with the oats and this plowed down after the oats is harvested and clovers raised with the wheat, the land can be improved and the returns increased. In the southern section of this area, previously referred to, in which oats unless sown in March or early April does not yield satisfactory returns, and because of which and also to have a growing crop on the land the corn stubble has been sown with wheat unless considerable quantities of commercial fertilizer are applied has not yielded inviting returns.

It is a question among the farmers throughout this section whether large returns could not be obtained by following different methods. Raising rye or an early ripening variety of wheat has been tried, and these crops followed with cowpeas, and these plowed down early in September with splendid results in the crop of wheat following. In several cases that have come to the writer's knowledge, the corn field after the corn was no longer benefited by cultivation was sown with grass, timothy, red and alsike clovers and alfalfa and splendid


Autumn Mean Temperatures
(Sept., Oct., & Nov.)
MAP No. 7
ERIE
CRAWFORD
WARREN
McKEAN
POTTER
TIOGA
BRADFORD
SUSQUEHANNA
WAYNE
MERCER
VENANGO
FOREST
ELK
CAMERON
WYOMING
LACKAWANNA
PIKE
LAWRENCE
BUTLER
CLARION
JEFFERSON
CLINTON
LYCOMING
SULLIVAN
LUZERNE
MONROE
BEAVER
ARMSTRONG
INDIANA
CLEARFIELD
CENTRE
UNION
NORTHUMBERLAND
COLUMBIA
MONTOUR
CARBON
NORTHAMPTON
ALLEGHENY
WESTMORELAND
CAMBRIA
BLAIR
MIFFLIN
JUNIATA
SNYDER
SCHUYLKILL
LEHIGH
WASHINGTON
HUNTINGDON
PERRY
DAUPHIN
LEBANON
BERKS
BUCKS
GREENE
FAYETTE
SOMERSET
BEDFORD
FULTON
FRANKLIN
CUMBERLAND
HARRISBURG
LANCASTER
YORK
ADAMS
CHESTER
MONTGOMERY
PHILADELPHIA
DELAWARE
Erie
Warren
Saegerstown
Tioga
Wellsboro
Austin
Emporium
Montrose
Le Roy
Towanda
Scranton
Wilkes-Barre
Milford
Greenville
Franklin
Grove City
Clarion
Parkers Ldg
Brookville
Renovo
Williamsport
Pocono Lake
Skidmore
Baldwin
Clearfield
Lock Haven
Lewisburg
Bellefonte
Center Hall
State College
Catawissa
Orifton
Stroudsburg
Mauch Chunk
Beaver
Beaver Dam
Freeport
Indiana
Saltsburg
Sunbury
Selinsgrove
Girardville
Gordon
Pottsville
Bethlehem
Allentown
Hamburg
Mifflintown
Davis Is. Dam
Pittsburgh
Derry Sta.
Johnstown
Huntingdon
Seisholtzville
Reading
Quakertown
Doylestown
George School
Greensburg
Newport
Lebanon
Claysville
Lock No. 4
California
West Newton
Lucinda
Reservoir
Somerset
Everett
Mountain House
New Germantown
Shippensburg
Ephrata
Lancaster
Pottstown
Norristown
Phoenixville
Coatesville
West Chester
Kennett Square
Aleppo
Greensboro
Uniontown
Confluence
Hyndman
Marion
Gettysburg
Hanover

Winter Mean Temperatures

(Dec., Jan., & Feb)

MAP N° 3

crops of hay were produced and the fertility maintained. But a practice that seems safer throughout this section, especially on the soils derived from the Micaceous rock, limestone, limy shale, shaly limestone, and other shales and some sandstone, is the seeding of crimson clover which thrives well and can be successfully started after corn is no longer benefited by cultivation or such crops as rye and crimson clover or rye and winter vetch can be started after the corn is cut. The rye or the rye and winter vetch can be pastured or cut for hay or silage and the rye stubble or the rye and winter vetch stubble, or crimson clover and rye, if these had been sown, plowed down and the land planted with soja beans. The soja bean after these have been raised for several years will yield larger bean and straw crops than wheat will yield wheat crops and will sell at a higher price than wheat and at the same time they will improve the soil while wheat exhausts it.

In the southern section of this area the long season cool weather legumes such as red and alsike clovers and alfalfa thrive as well as the hot weather mammoth and the short season cow peas and soja beans. With the possibility of raising such an array of soil improving crops, any phase of grain farming or the livestock industry can be sucessfully undertaken and with the right use of the farm manures the land can be improved. It is a question whether the soja bean should not take the place of wheat and oats in the rotation and the farmers of this section supply the farmers of the northern areas with this high protein food and the farmers of the northern and higher altitude areas supply this southern and lower altitude farmer with oats. This might become a profitable exchange of crops. This south-central, southeastern and southern area is also the tobacco section of this State and all the tobacco which has become recognized as one of the most profitable crops is being raised here. The mean temperature of the whole State is sufficiently high for such crops as are not harmed by the first killing frosts among the legumes, the red, alsike, Mammoth and crimson clovers and the winter vetch, and among the cereals, rye, wheat, winter oats and barley, and among other crops, rape, cowhorn and other turnips.

AUTUMN MEAN TEMPERATURE

The mean temperature of the three fall months, September, October and November, is higher by from two to four degrees, probably due to effects of the Atlantic Ocean in the southeastern, eastern and northeastern areas and eight degrees higher along Lake Erie, than in other sections of the State demonstrating, as previously indicated, in a remarkable way the equalizing effects of large bodies of water on the seasonal temperature of a country. The first killing frosts, because

of the larger heat storing capacity of water and the giving up of this heat day and night to the cooling air, is delayed until October 30th, the same as in the vicinity of Philadelphia and the northern part of Delaware nearly 200 miles further south making it possible for such fruit crops as grapes, climatically adapted to this northern section, to accumulate a large amount of sugar and attain a flavor which, under sudden fluctations of temperature such as occurs away from large bodies of water would not be possible.

Similar variations as those in the eastern part occur in a small section in the southwestern part of the State where the first killing frost is staid until October 30, probably due to less precipitation. A small section in which the fall and spring mean annual temperatures are similar occurs in the northeastern part of Lawrence and the southwestern part of Mercer counties, probably due to the fact that this section is uninfluenced by the moderating effects of water and is entirely subject to inland conditions. The mean fall temperatures of the whole State is sufficiently high except probably in those areas where killing frosts occur by or before September 30; which are very limited, for such crops among the legumes as crimson, red, alsike and mammoth clovers and the winter vetch and among the cereals, rye, winter wheat, oats and barley and among other crops rape, cow horn turnips and other turnips as well as a number of varieties of beets to go on growing throughout the greater part of October, and in the areas embracing the 52 degree isothermal line and from there up growth of these crops will continue especially in the southeastern section of the State frequently until the middle and toward the end of November.

The climatically adapted sugar beet area of the United States, according to Bulletin No. 52, U. S. Department of Agriculture, 1908, by Dr. H. W. Wiley, passes along the 70 degree isothermal line, including all of the moderately rolling sections of the northern part and the more fertile soils of the higher elevations of Somerset county, in the southern part. These areas and their soils are not, as a whole, adapted for growing beets containing a high percentage of sugar, but in a general way the more rolling sections of the glaciated area, especially where the shaly Catskill and the coal shale formations together with the glaciated material form the soils, of a succulent and highly nutritious foods. Such a tonnage can be raised on four or five acres as will enable those who do not care to make the expense of building a silo stored and in a cheaply constructed beet cellar under the barn bridge or close to the barn or feeding shed, that will carry through a herd of from ten to twenty animals and keep them in splendid condition; and what is still more desirable, this can all be done with less work than filling a silo. As

high as twenty tons of beef have been raised per acre in the southeastern section of the State where climatic conditions are not so favorable.

The areas where comparatively dry and cool weather prevails during the ripening season are best adapted for the accumulation of a large percentage of sugar. Dr. Wiley, in Bulletin No. 52 (revised) U. S. Department of Agriculture, 1899, says: "It is evident, however, that in the northern and western portions of the State, where suitable soils can be found, the culture of the sugar beet may be introduced under the most favorable conditions and with every prospect of success." Crimson clover can be started before the beets are harvested and made a cover crop for the winter. Under the discussions of the origin of soils it was stated, that the soils are brought into existence through the energy of the sun, and also that plants are storers up of the sun's energy and, therefore, whenever possible plants should be kept on the soil at all times to take up the fertility as it is made available and store it together with the suns energy as long as it is not too cold for plant juices to carry on this operation, and after this period, to hold these until the agencies of decomposition can again make them available for future plant growth. The early fall temperatures ranging from the isothermal or equal temperature line of 50 degrees and upward are splendidly adapted for ripening red, alsike, Mammoth clovers and alfalfa seed as well as buckwheat, and wherever possible, especially wherever the sod is to be plowed for corn, should these seeds be ripened and hulled and the straw returned to the soil and the seed used for raising these legumes. The area from the isothermal or equal temperature line of fall mean temperature of 50 degrees and upward are also adapted for ripening corn which throughout these areas is the most valuable cereal crop and for starting the winter cereal crops such as wheat, rye and winter oats and barley.

WINTER MEAN TEMPERATURE

At no place in Pennsylvania is the winter temperature so low as to injure the crops previously suggested as adapted to the various sections of the State and the air normally at all times contains sufficient humidity during the winter to protect the moisture of fruit trees so that even low temperatures do not harm them. Like the annual mean temperature, there is a difference of ten degrees, between 23 degrees the lowest winter temperature in the northeastern part of the State and 33 degrees the highest in the southeastern part.

THE ADAPTABILITY OF THE CLIMATIC CONDITIONS OF PENNA. FOR FRUIT GROWING

Much has been written on this subject and it is only necessary here to refer to the climatic conditions as they appear from the charts previously discussed. The average date of the last killing frost in the spring ranges from April 10, in the southern and southeastern part of the State, except in a limited section in Somerset county and in parts of Crawford, Warren, McKean, Potter, Cameron, Elk, Forest, Venango, eastern Mercer, northern Butler, Clarion, Jefferson and northern Clearfield counties, to May 8, in the remainder of the State, which, according to the date of the first killing frosts, makes a growing season in all these higher elevations and northern areas except in a limited section in Potter and Tioga counties of from 140 to 150 days. This is a sufficiently long season to ripen a crop of fruit and to grow and ripen a wood growth with sufficient strength to produce a crop of fruit every season providing the fruit is thinned and the best types of soil improving crops that can be grown under prevailing climatic conditions are raised and allowed to remain on the soil. In the areas in which the dates of the last killing frost in the spring vary between April 10, and April 30, and the first killing frost in the fall between October 10, and October 30, larger crops of well developed, highly colored, nicely flavored apples and peaches can be raised, providing the soils are adapted for fruit raising, than anywhere in the State.

Carbon county lies along the boundary of this area. This county contains a considerable acreage of Catskill and Catskill Chemung soils splendidly adapted for raising the best developed, highly colored, nicely flavored apples and peaches which together with the climatic conditions such as comparatively cool summers and long cool falls prevailing throughout this and parts of Schuylkill county should make this region one of the first fruit sections of the State. Both climatic and soil conditions combine to make the South Mountain area the great peach growing section of the State with a close second on the Clinton shales along the Medina and Oneida sandstone formation.

CLASSIFICATION BY COUNTIES

PART TWO

POTTER COUNTY*

Potter county lies north of Cameron and Clinton counties, east of McKean, west of Tioga, on the New York State line. The geological strata underlying the county and from which the soils are derived, together with some glacial action, range from the Chemungs, which outcrop in the northwestern part up through the Catskill, which occupies the valleys and hillsides and the tops of the lower hills, with some of the lower hills covered with Pocono sandstone; some still higher with thin sections of Mauch Chunk red shale, which, where it is not mixed with Pottsville conglomerate, makes among the best cereal grain and grass soils in the county; while, where the red shale is mixed with the Pottsville conglomerate, which lies on top of the Mauch Chunk, the soil is poor and largely unfitted for farming. The highest outcropping strata are the remanents of the lower coal series, which, wherever sufficient of these measures remain, the soil is fairly fertile. The elevations above tide range from 1,481 feet at Port Allegany, in McKean county, on the eastern border of Potter, to from 2,500 to 3,000 feet on the higher elevations.

The drainage of the county is accomplished by Kettle Creek and its branch, which drains the southeastern corner of the county and flows into the Susquehanna River, by the Sinnemahoning and its tributaries, which drain the southwestern section and also flows into the Susquehanna. The Allegheny River rises in this county, near the line between Ulysses and Allegheny townships, and flows westward, draining a large section of the central part of the county, and flowing into the Ohio River system. Oswego Creek and its branches drain the northwestern corner of the county. The Genesee River drains the north central part, the Cowenesque Creek the northeastern and Pine Creek the eastern central part. From this, it is evident that Potter county is sort of the pique of the roof of the State from which the water flows into the Susquehanna River, into the Mississippi and into Lake Ontario. It is evident, from the strata enumerated above, that a large acreage of this county is not adapted for farming, and that it should be reforested, or should be allowed to reforest itself.

STEWARDSON TOWNSHIP

This township occupies the southeastern corner of the county and has the Clinton county line for its southern and the Tioga county line for its eastern boundary.

*On the 26th of March, 1804, an act of Legislature was passed naming Potter Co. and defining its boundaries but it did not attain its full organization until 1835; all this time having been attached to Lycoming county for executive and judicial purposes.

The soils of the township are formed of the Catskill, the Pocono, probably some small sections of Mauch Chunk, with thin covering of Pottsville conglomerate. The agricultural land is largely confined to the Catskill formation, which enters the northeastern part of the township from Tioga, in a belt about two miles wide and leaves it in the southwestern corner. The soils, on this upward curve of the strata for such it is, are formed largely of the red, with some intermixture of grey shales. The land is hilly and rolling, and where disintegration has proceeded sufficiently far to form loams and clays, some good grain, especially oats, buckwheat, grass and potato soils occur, with a decided preference for grass and apples. The remainder of the township, with the exception of some places along Kettle and Cross Forks creeks, which drain the township, the soil is rough, hilly and not suited for farming, and should be retained in forest for which it is adapted.

Wharton, Oleona, Abbott and West Branch have soils derived from similar underlying strata. Wharton township occupies the southwestern corner of the county with the Clinton county line for its southern and the Cameron county line for its western boundary, while Oleona lies directly east of it; also on the Clinton county line. The southern part of Oleona township is very hilly and rocky with steep ravines and with little farming land. The central part is occupied by the Catskill and contains some farming land also hilly and difficult to farm.

WHARTON TOWNSHIP

The same Catskill formation, referred to in Oleona township, crosses this township in a southwestern course with a width of from three to four miles with a red soil, derived from nearly horizontal strata. This section contains an upland divide from which the streams flow northward into the Sinnamahoning and southward into a number of smaller streams, with some land sufficiently rolling for farming and apple growing. The northwestern corner of the township is very hilly, and while forest trees grow and an undergrowth of great density thrives, yet the soil is not adapted for agricultural plants and will not for any length of time and with any degree of perfection grow them.

ABBOTT TOWNSHIP

Abbott township lies north of Stewartson, along the Tioga county line. The southeastern corner, or in fact the whole of the southeastern and southern section of the township, is a high mountain plateau upon which, between the streams, are some high, moderately rolling tablelands, with soils formed of Pocono, Mauch Chunk, conglomerate and coal strata. Some of these soils will produce, among the cereals,

oats and rye, and the better types would produce wheat if the land would be well farmed. Potatoes and buckwheat yield paying crops. The Baldwin and the Northern Spy apple thrive here and can be made a paying crop. Some pasture lands also occur which should be used for stock raising. The central and northern part of the township is located in a Catskill Valley about four miles wide, cut up by a number of streams, such as Kettle Creek, Little Kettle Creek and Cross Forks and their tributaries. On the divides between these streams is some moderately rolling land of good fertility on which the natural pasture grasses grow, and which, with good farming, can be made to produce large hay and pasture crops. A timothy sod can be started in corn. With good farming, the application of manure and a little lime, such an amount as is contained in basic slag will do splendidly with wheat. Oats, flint corn, rye and barley should yield profitable returns when fed into animals.

The soils are formed usually of the Catskill red shale. Northern Spy apples thrive here and this should be made one of the places for raising this fruit. Usually at the confluence of several streams, are sections of farming land which are fertile but sometimes too wet to farm, when this is not the case these soils are the most productive in this section. Some of this land is very moderately rolling.

WEST BRANCH TOWNSHIP

This township lies north of Abbott, along the Tioga county line. The Catskill formation, already discussed in Abbott township, passes through the southeastern part of the township and covers approximately one-third of it. The configuration of the township is the same as that of Abbott, except that it is more moderately rolling and is more accessible as the formation extends into Tioga county where this and the Catskill formation, discussed in Stewardson township, unite or come together and form the spendid Wellsboro Valley, discussed in the report on Tioga county.

These soils are adapted for hay raising. Some of the lowlands have a rich soil adapted for trucking, celery and onion raising, for which all that is available should be used. Most of the central and northern parts of this township is occupied by the Pocono, the Pottsville and some remanents of coal bearing strata, which means that this is a rough and hilly and little fitted for agriculture country, all of which is well adapted for growing forests of a desirable and paying type and should by all means be utilized for this purpose.

Summit, southern Homer, Sylvania and Portage townships are well nigh entirely occupied by the great central plateau, already referred to in the discussion of West Branch township.

SUMMIT TOWNSHIP

Summit township lies west of West Branch. The whole of it is occupied by the great central plateau of the county, with soils formed of the Pocono and the conglomerate, with a considerable section of coal measures remaining in the southern part of the township, forming a soil on these high lands that will produce some of the agricultural crops in paying quantities. But from all appearances, the land should be in forest. In the northwestern corner of the township a small farming section of Catskill soils occurs.

HOMER TOWNSHIP

This section belongs to the same formation as Summit township, that of the central plateau. This, again, is a very hilly township, with farming land occurring only in small patches on the uplands between the gorges of the streams, which, in the northern part, branch out in all directions.

In the southeastern corner of the township is a rolling highland section, with soils of Pocono sandstone, splendidly adapted to raising forests. A similar formation occurs east of north Wharton, in Sylvania township, with similar adaptation. This is also good grass soil, and large parts of both sections could, with care, be made a permanent pasture of considerable value, which would be very desirable.

PORTAGE TOWNSHIP

Portage township lies directly west of Sylvania, on the Cameron county line. The upland of Pocono sandstone, referred to in the southwestern corner of Sylvania township, extends across the south central part of this township, with soils of similar adaptations. The same formation prevails in the northwest section of the township. Otherwise the township is a country of hills, with high walls and narrow sections of uplands, best fitted for growing forests.

SYLVANIA TOWNSHIP

Sylvania township contains one of the small coal fields of the county, in which are soils adapted to farming. But usually the land is very rough.

KEATING TOWNSHIP

This township lies north of Portage and west of Homer, on the McKean county line. The township lies north of the great plateau, but its soils are formed well nigh entirely of the same strata as underly the plateau section, with the exception of a small lowland in the eastern part of the township, the soils of which are derived from the Catskill. This would make splendid pasturing land, because the

pasture grasses, such as timothy, grow without any farming. The remainder of the township should be in forset. This, like many sections of Pennsylvania has been burned over and over so often that in many places forest trees will no longer grow; and unless these are again started, permanent destruction will begin. What is stated here, is true of the other townships throughout this section.

ROULETTE TOWNSHIP

Roulette township lies north of Keating, along the McKean county line. This township is hilly and much of it difficult to farm, but the soils, which are largely formed of the underlying Catskill red shale strata, can, in many places, be farmed, and can be made to produce paying crops of buckwheat, potatoes, timothy, rye, oats and Canada field peas and oats at such places as along the valleys of Fishing Creek and the Allegheny River and other streams, and on the rolling upland extending from the central part of the township northeastward into Eulalia township. The land in many places is rough, the soil strewn over with stones which makes farming difficult. Some glacial drift occurs along Fishing Creek and the Allegheny River, which enters into the formation of the soil, in most places, with good effect.

EULALIA TOWNSHIP

This township lies east of Roulette and north of Homer township. The Catskill strata form the soils in the southeastern and northwestern corners of the township, while between these two formations the hilly and sometimes even mountainous country is covered with grey and brown sandstone of the Pocono formation. The valleys cut down by the streams, flowing into the Allegheny River, which flows through this township in a deep gorge, cut into the Catskill and usually where confluences of streams occur, as at Coudersport, the county seat of this county, sufficient of the Catskill strata appear to make a congenial soil for agricultural crops to be raised successfully. With the exception of the southeastern and northwestern corners, where the land, with the soils formed of the underlying Catskill strata, as already indicated, is somewhat rolling, the country is hilly, with hills not as high and steep as farther south, but difficult to farm. But wherever on top of the hills a section of rolling land occurs, it is successfully farmed. The pasture and hay grasses grow naturally along the roads and wherever good farming is done yield paying returns.

SWEDEN TOWNSHIP

This township lies east of Eulalia and north of Summit. The Catskill Valley, which extends through the southeastern corner of Eulalia and Homer townships, forms a broad, open, hilly country, extending through the central part of the township, making the farming soils. The southeastern corner of the township lies within the central plateau already described, and is very hilly, except where the coal shales remain on the upland. The northwestern corner of the township is also in the Pocono formation, and is hilly, but not as hilly as the southeastern section.

JACKSON TOWNSHIP

Jackson township lies east of Sweden and north of West Branch. In the northeastern corner of the township, where an upward curve of the underlying strata ends, Cushing and Pine creeks have sufficiently eroded the country to form some Catskill soil. Otherwise, with the exception of some upland formation sufficiently rolling to admit of being farmed and some broadened valleys along the streams, this is too hilly and mountainous for farming and should be in forest, which grow splendidly.

PIKE TOWNSHIP

Pike township lies east of Jackson on the Tioga county line. In the southeastern part of this township, the southern branch of the great central plateau extends into Tioga county and forms a very hilly country. On this southern hilly country, in the southeastern part of the township, a coal vein of considerable extent has been preserved upon which some farming land occurs with soils of fair fertility. Pine and Phoenix creeks and their tributaries cut deep gorges through the central and eastern section of the township, with some plateau land between them. In the northwestern part of the township, where the upward curve of the strata, already referred to, raises the Catskill and the upper strata of the Chemung series to such an extent that these form the soil, an agricultural section begins extending into Hector township with agricultural soils of better fertility than any encountered further south. Through the central part of the township, the Catskill strata form a rolling section, approximately a mile wide, north of which the Chemungs occur, both making the soil referred to.

HECTOR TOWNSHIP

This township lies north of Pike on the Tioga county line. The Chemung strata, referred to in Pike township, make the soil of the southeastern part of this township. The softer Catskill strata lie to the north of this Chemung formation and make a rolling farming

country of fair fertility. This Chemung Catskill formation extends into Tioga county, where it makes the broad valleys of Mixtown, Nelson and Lawrenceville, described in the discussion of that county. The central part of the township is a mountain belt, with uplands of farming soils adapted for such crops as buckwheat, oats, pasture and hay grasses; but better adapted for growing forests.

ULYSSES TOWNSHIP

This township lies west of Hector and north of Jackson. The Pocono hills, already referred to as passing through the central part of Hector township, occupy the southeastern corner of this township, on which occur some farming land on an upland between branches of Genesee Forks and Pine Creek, largely of Pocono sand. The Pocono also remains in the northwestern corner of the township with a hilly country. The entire central part of the township, from the northeast to the southwest, is underlaid with the Catskill strata, and the soil is derived from these rocks. This formation has an average width of, approximately, four miles throughout this township. This same Catskill formation, as already intimated in the discussion of these townships, extends in a southwestern course(through southeastern Allegheny, central Sweden, southeastern Eulalia, northwestern Homer, into Keating township, with soils adapted to agriculture throughout its entire length showing in this, as in so many other counties in this section of the State, that the Catskill strata make the farming soils. The town of Ulysses is located in this Catskill Valley, surrounded with agricultural soil. This location is elevated, which is well attested by the fact that the Allegheny River, flowing into the Gulf of Mexico, the Genesee, flowing into Lake Ontario, and the Susquehanna, flowing into Chesapeake Bay, all have their head fountains in this township. The Catskill Valley widens northward as it approaches Bingham and Harrison townships, which occupy the northeastern corner of the county.

BINGHAM AND HARRISON TOWNSHIPS

Bingham township lies directly north of Ulysses with soils formed of the Catskill red shale. Some Pocono sandstone remains in the southwestern corner of the township in a number of hills, with rather rough soil, while northward throughout the township and in the southeastern corner the highlands formed of Catskill strata, with the addition of glacial drift are rolling, with soils easily farmed and productive. This is one of the most fertile farming sections of the county, with soils adapted to raising the hay grasses, flint corn, oats, with good farming, winter wheat and rye. Buckwheat is a very desirable crop for this section, so are potatoes in the deep loamy

soils. Apples would likely make the best paying crop in this section, especially the Northern Spy. A rotation of crops by means of which the largest amount of roughage and grain could be raised would be silage corn for the silo, flint corn for grain, Canada field peas and oats for hay, oats for grain and timothy and clover for hay. This could be made a three or four years rotation. The seeding grass could be done after the cutting of the pea and oat hay, or it could be seeded with the peas and oats in the spring.

HARRISON TOWNSHIP

Harrison township occupies the northeastern corner of the county. This is an open country, with rounded hills, formed of Catskill strata, with deep soils of good productive capacity and with wide and comparatively shallow valleys along the streams, with soils formed of the Chemung strata also of good productive capacity. Harrison valley is one of these sections and is representative of others in this township. This is one of the natural dairy sections of the county and should be utilized for this purpose. Clovers thrive here when the land is well cultivated. Silage corn does well and a large crop of flint corn can be ripened. Potatoes are a paying crop when well farmed. The lower red shales of the Catskill form the Catskill soils on the hills, while the upper Chemung strata form the soils of the valleys. On a divide in the northwestern section of this and the northeastern part of Bingham township, is some moderately rolling agricultural land of good productive capacity.

GENESEE TOWNSHIP

Genesee township lies west of Bingham and north of Allegheny townships on the New York state line. The Catskill strata form the soils of the southeastern section of the township south of Ellisburg. The upland is rolling, and with good farming, produces paying crops of hay, oats, corn, potatoes, buckwheat, rye and clovers. Alfalfa has been raised in this section. When this examination was made, the writer examined several small patches the regular nitrogen gathering nodules were found on the roots, and wherever this was the case the plants looked thrifty. If alfalfa will grow successfully here, it will grow in Bingham and Harrison townships, probably better than in this section. With alfalfa hay, the dairy problem of this section would, in a large measure, be solved. A Pocono plateau, with deep ravines, covers the central part of this township. The soil is not fertile, but is well adapted for growing forest, with which it would at this time be covered had it not been burned over. The northern part of the township, along the New

York state line, contains the Chemung belt of Oswayo township, south of which the Catskill form a narrow strip of red shale farming land between the Chemungs and Pocono.

HEBRON, CLARA, AND PLEASANT VALLEY TOWNSHIPS

These three townships lie directly west of each other, beginning with Hebron, which lies west of Allegheny, followed by Clara, which lies wies of Hebron and by Pleasant Valley which lies west of Clara on the McKean county line. These townships have very similar soil formations. The same Catskill valley that passes through southeastern Genesee, crosses the central part of Hebron township and makes the largest farming section of the township. These soils are adapted for the same crops as the townships already described. The other sections of the townships have soils formed of higher strata than the Catskill, with similar adaptations as those of the same type previously discussed.

CLARA TOWNSHIP

The mountainous country which crosses northern Hebron occupies nearly the whole of this township, except a strip along the northern part where the Catskill comes to the surface, and in the narrow valleys along the streams and in the southeastern corner, where the same strata form the soil. Some rolling land occurs in the central part of the township on the Pocono strata which seems fairly productive, but from the appearances of the forests, should be growing this crop.

PLEASANT VALLEY TOWNSHIP

The same mountain coming in from McKean county and which extends through Clara township into Hebron, nearly completely covers this township except along the northern part of the township where some Catskill soils occur and where some successful farming is done.

SHARON TOWNSHIP

This township occupies the northwestern corner of this county and has the New York State line for its northern boundary. The soils of this township are largely derived from the Chemung strata, except the southeastern corner, where a few small sections of Catskill, remain and form the soil and in the northwestern corner where a considerable section also remains. This northwestern corner is probably the most fertile farming section of the county, the land is moderately rolling, some of it along the streams is low and spouty and needs underdraining, but the greater part of it is sufficiently elevated, that with deep tilage, will not need drainage. The land is easily farmed and responds splendidly to good agricultuaral treatment such as intense cultivation, manure, lime and fertilizer. The

clovers thrive here. The hay grasses such as timothy, yield large crops. Wheat it seems could be made a large yielding crop, and it seems that spring wheat should thrive here. Alfalfa has been raised, but with what success could not be definitely ascertained.

Dairying is the industry in this section and the soil is well adapted for this business. The section through the central part of the township occupied by the Chemung formation, is more hilly than the northwestern Catskill corner, but not too hilly for successful farming. At Shinglehouse, in the western part of the township, along the Oswayo Creek is a comparatively wide valley of rolling land containing among the best Chemung soils in the State. South of Shinglehouse and south of Oswayo Creek, about the hills along the valleys of the streams, is a beautiful farming section with soils derived, on the higher elevations, from a combination of Chemung and Lower Catskill, which invariably makes a desirable farming soil, which is the case here. In the central and northeastern parts of the township, several more such sections occur with similar soils, all adapted to raising the crops above referred to, especially wheat, which should do well on these soils. As already stated in connection with the discussion of the Catskill area of soils, this also is a dairy section, and it seems that a rotation of crops that would yield a large amount of roughage and considerable grain would be silage corn for the silo, flint corn for grain and Canada field peas and oats for both grain and roughage, and clover and timothy hay. Such a rotation could easily be followed here. The underlying strata throughout this township are well disintegrated and, consequently, the land is not as rocky and stony as these formations frequently are. The land along the streams is rolling and some of it very fertile, adapted to intensive farming. Some of these soils are spouty and need drainage.

OSWAYO TOWNSHIP

This township lies east of Sharon on the New York state line. The northern part of the township is underlaid with Chemung rock, and the soil in this section is derived from the same strata as those of central Sharon township, with similar adaptations. An upland of rolling country occurs in the northern part of this township, very similar to those discussed in Sharon township. South of the Chemung formation, along Eleven Mile Run, the Catskill and the Chemung again combine to form the soil, with, wherever this is the case, good results. Farther south the Catskill red shale forms a belt of good soil, about a mile wide. The southeastern and a large part of the southern and eastern parts of the township contain remanents of the Pocono highlands, which are, however, not as steep and contain some land which can be successfully farmed, and

could, with better treatment, be made more productive. The hills of this county are steeper and more precipitous than the hills of the counties farther east because the glacier, which covered these counties, did not extend far south into this county and, therefore, the scouring and rounding of the hills does not occur here.

This statement must not be construed in such a way as to give the impression that little of this land can be farmed, because this is not the case. A farmer in this county, with careful selection of seed and by good agricultural practice, has developed a type of flint corn that will invariably produce two well sized ears on each stalk, and yield from sixty to a hundred bushels of shelled corn to the acre. Certainly this is being done on the best types of soil.

McKEAN COUNTY

McKean county was separated from Lycoming county by Act of March 26, 1804. It was named after George McKean, but was not organized for judicial purposes until 1826. It contains 631,680 acres, of which 159,150 acres is land in farms, and of which 66,822 acres is improved farm land. 617 acres were planted with corn in 1909, yielding 14,689 bushels; 6,159 acres were sown with oats, yielding 144,526 bushels; 137 acres were sown with wheat yielding 1,743 bushels; 2,177 acres were sown with buckwheat, yielding 29,327 bushels; 73 acres were sown with rye, yielding 1,264 bushels; 1,901 acres were planted with potatoes, yielding 163,966 bushels; 27,234 acres were sown with all forage crops, yielding 34,122 tons of the various kinds of hay. Of the 66,832 acres of improved farm land, 38,298 acres were used in raising farm crops while 28,524 were not so used were likely producing weeds. At this time, McKean county had a population of 47,868 to feed, 14,324 cattle, 3,046 horses, 29 mules, 4,026 swine and 4,769 sheep.

The outcropping rock of McKean county from which its soils have been formed through the agency of both glacial rubbing down and by disintegration, begin with the Chemung shales in the valleys of the streams, followed a little higher up by the Catskill shales and sandstones, and by the Pocono sand, culminating with extensive uplands of Olean conglomerate, Kinzua Creek sand and the shales and sandstones of the lower coal measures. The Allegheny River, through its branches, Potato Creek, Marvin and Portage creeks, and

many smaller streams, drain the eastern section of the county northward into New York, while the Tuneaugwant drains the northern central section, and Kinzua Creek, with smaller branches of the Allegheny, drains the western section.

Innumerable ravines descend in all directions from the flat narrow divides into which the tableland, at one time unbroken, is now cut up. The upper or higher slopes of these ravines, wherever the rock of the lower coal measures are hard, are cliffed, where the coal measures are shaly, the slopes, because of glacial action and by disintegration, become more rolling. The same thing is true of the three divisions of the conglomerates, while the massive Pocono sand rocks show their resisting power to all disintegrating agencies, but are undermined and broken down because of the more readily disintegrated rock of the Catskill formation, underlying them. The highlands of well nigh the whole county are covered with the rocks of the lower productive coal measures, accompanied, in a few places, by the limestone strata of this formation. The soils divide themselves into two groups: Those derived from glacial action and the disintegration of the lower productive coal measures, the Pottsville conglomerates, and the Pocono and those influenced by the Catskill and the Chemung, through the same action.

NORWICH TOWNSHIP

Norwich township occupies the southeastern corner of the county and belongs to the coal formations and their accompanying rocks. It is extremely hilly, and farming is difficult, except in the region of Potato Creek in which is a considerable acreage of soil well adapted for agriculture, formed of glacial drift and the rock brought down by glacial action from the formations of higher strata as well as by disintegration of the underlying rocks.

At Norwich is a tract of 26,000 acres of original timberland that has never been cut over, composed largely of hemlock, some pine and beech and maple. It is evident, from the timber growing here, that the soils are adapted to produce just such a forest because the undergrowth is such that in very many places the sunlight can not penetrate through to the soil; and it seems the struggle for existence among the various species of trees is not for fertility, but for sunlight. For this reason, the united efforts of State, county and township should be made to get these trees to re-occupy the land so well adapted to their growth after the original forest has been cut away.

The soils on the higher or forest lands of this township in the third Bituminous coal basin, are derived from the disintegrated coal shales,

slates and sand rock, which contain little or no calcareous or limy formations. Glacial action, together with the agencies of disintegration, have rounded the hillsides to a certain extent and have made a deeper soil here than is usual where the agencies of disintegration alone have been in operation. But so little farming is being done and so little has been done that little is known of the capacity of these soils except wherever the forest has been cleared away, there a sod will form in a few years and produce pasture of a desirable character that will last for years unless pastured to death as has been done in many places in this county.

Sergeant, Hamlin, Lafayette and Wetmore townships have soils derived from similar rock strata.

SERGEANT TOWNSHIP

Sergeant township contains a larger portion of carboniferous rock than any township in the county, and, therefore, the general elevation is greater. Chapel Hill and one other nearby peak are said to be between 2,400 and 2,500 feet above ocean level, while the lowest elevation, where West Clarion Creek crosses the boundary of the county, is 1,600 feet above. This township is directly north of Jones township, Elk county, and the formations there discussed prevail here to a very large degree, except that the coal formations rise higher and higher until they pass out entirely and lower formations occupy the ground.

This intermingling of these lower formations and the disappearance of the limy shales and the limestones, changes the productiveness of these soils.

At Clermont, close to the eastern border of this township, the ferriferous limestone was first studied and its position in the geological strata determined. It outcrops between Clermont and Warner Brook. The vein is about six feet thick and consists of bluish grey stone which has been burned into lime and used for agricultural and building purposes.

A drill hole run down near the township line between Norwich and Sergeant pierced the vein and found it to be eight feet thick. (2nd Geo. Survey Pa. Vol. R, Page 128.) This should be investigated and if there is such a vein, its outcrop should be located because it would be of so much value to the agriculture of this section.

An investigation of the rock underlying the soils of the flats and uplands of this township, revealed that the larger section is composed of a shaly sandstone, rather easily disintegrated, producing a soil that is easily cultivated where it is not too steep. The hard pan, if it exists, does not come close to the surface. Its existence is doubtful, in many places.

These soils will produce a good sod and pasture and will yield splendid hay crops as well as potatoes, buckwheat, oats. The Lower Pocono limestone is also exposed at Barrett's Corners, and has a thickness of 5 feet. This limestone has been burned in some places for agricultural purposes.

HAMLIN TOWNSHIP

Hamlin township lies north of Sergeant and south of Lafayette. Marion Creek flows through the southeastern corner of the township and drains it as well as exposes the Catskill sandstone. In the extreme southeastern corner, pieces of the ferriferous limestone have been found and the effects of this formation, through disintegration, show in the vegetation.

Not only are the effects evident, but a superior agricultural section of soils, beginning here, extends through the northwestern corner of Sergeant township on to Smethport, the county seat. Along this same creek another limestone crops out which will be referred to later. Certainly the limestone has not been noticed anywhere except the place referred to but these strata may at some time have extended along here.

The central part of the township is occupied by what is known as Big Level referred to in Elk county, coming in from New York State. Mt. Jewett, at one time Howard Hill, is located about the center of the township on a big flat surrounded by an elevated table-land of soils made of glacial drift and from the ground and broken up and disintegrated surface rock of this section. A fairly fertile soil occurs here, underlaid in some sections especially on the brows of what were at one time hills, with a hard pan usually within a few feet of the surface, while in other places it is down much deeper or does not exist at all.

These soils contain gravel mixed with a loam and produce hay—as much as three tons to an acre have been cut at one cutting—oats, buckwheat, and potatoes also thrive here. These soils should be plowed deeper than they now are and should be cultivated more and should have an application of lime and some commerical fertilizer with all the manure that can possibly be made. The small amount of organic matter they contain is an evidence that little attention has been given to supplying this most essential substance by the application of manure or plowing down heavy sods such as these soils will readily produce.

There is a difference in elevation between the summits of Howard Hill and where the Kinzua Creek crosses the northern boundary of the township of 668 feet or between 2,268 feet and 1,600 feet above

tide. This elevation must be taken in consideration in the agriculture of this section. The western section of the township is similar to Wetmore.

WETMORE TOWNSHIP

Wetmore township lies west of Sergeant and Hamlin in the southwestern corner of the county. The rocks exposed in this township from which, together with the glacial drift, the soils are derived, are the coal strata, the Mauch Chunk and the Pocono sandstone.

The coal shale and drift soils are well illustrated in the vicinity of Kane where the Swedes have established an agriculture superior to any thing that has been done on these soils, except, probably, in isolated places, and where has been illustrated what these soils will do under good treatment.

The section belongs to the Big Flat, already referred to, and is rolling land, with few hills. too steep for farming operations. The soils are sandy in some places, but mostly loamy, with some gravel, and to yield paying crops need only good cultivation, with the application of manure, the plowing down of heavy sods and some liming because, as already indicated, these coal shales are deficient in lime. With this kind of treatment crops not usually raised in this section will be produced.

LAFAYETTE TOWNSHIP

Lafayette township is located in the central part of the county, south of Bradford and east of Corydon. The elevations above tide vary from 2,100 feet in the southern part to 2,225 in the northern sections of the three plateaus into which the township is divided.

The eastern or Alton plateau is about 11 miles long and about five miles wide at Alton and Buttsville. It extends northward into Bradford township, southward into Hamlin and eastward into Keating. The surface is very gently rolling and the soils, though mixed with glacial debris, contain more of the underlying disintegrated rock formation than any other constituent and are more or less fertile, as the rocks from which they are largely derived contain more or less of the elements of plant nutrition. At the town of Kushequa and thence to Newton are some good farming lands on this plateau, where general farm crops such as timothy, red clover—when lime is applied—potatoes, buckwheat and corn for silage will thrive. But these soils are better adapted for pasture lands than for any other crops. The pasture grasses will thrive here abundantly as soon as the forest is removed and in so far as possible these soils should be devoted to raising this roughage.

This is the more fertile of these plateaus. The shales largely underlying it are the softer and likely limy shales of this formation perhaps some remanents of the ferriferous limestone might occur.

The Lafayette or central plateau of this township extends from west of Kushequa northward to Bear Run and between Lewis and Wintergreen runs on the west and east branch of the Tuneangwant Creek on the east. The highest measures on this plateau are those underlying the ferriferous limestone, which is manifest in the timber and the crops that grow here.

The third of these plateaus lies west of Lewis and Wintergreen runs and extends from Custer City, through Marshburg, to some distance north of Kinzua Creek along Turnip Run and thence westward through the central part of Hamilton township.

On these plateaus is a large acreage of land on which a definite succession of crops to maintain animals or for growing apples, potatoes, buckwheat, and such crops as will best thrive should be started or the land should be reforested and the burning of it over year after year should be stopped or serious results will follow. Apples, potatoes, buckwheat and the hay grasses do well here.

Corydon and Bradford townships have much of the plateau land, a large part of which should be reforested. Along the road from Bradford to Corydon, in Warren county, on the divide between Marilla and Willow creeks, the Marshburg plateau is in evidence. South from here is a rolling upland not as large in area as the Marshburg, but formed of the same shales and produces the same crops.

Northward this plateau is not as extensive, but contains the same soils. Westward along the road at Calburn farm these soils were thoroughly inspected and their formation found to be similar to those on the plateau further south. They produce well when well farmed and do not wash. Westward from Calburn on one of these plateaus, oak and chestnut timber was found to grow and the undergrowth was of such type to demonstrate that limestone or limy shales had disintegrated here. This soil produces well such crops as wheat, which usually does not thrive in these soils.

In the vicinity of the town of Bradford, in the valleys of the branches of the Tuneangwant Creek, flowing north into New York State, are splendid farming sections. Where West Branch and East Branch and Marilla creeks flow together the hills are not so steep and are rounded and the valley is wider having been filled with the disintegrated rocks of the hillsides and by glacial action so that the soils are deep and fertile and will produce all farm crops that will thrive in this section.

North of Bradford, at Babcock, the valley of Tuneangwant Creek, where Foster Brook flows into it is fully as wide and as fertile as further south and adapted to the same crops such as hay, oats, Canada field peas, clovers and flint corn. Northeastward to Derrick

City the valley contains the same soil formations and the hills naturally become pasture lands as soon as the forest is cleared away. The same is true of the soils along Kendall Creek.

KEATING TOWNSHIP

Keating township lies east of Lafayette. Smethport, the county seat, is located in this township. At Newton the platteau is extremely stony and the only thing the soils is adapted for is the growing of forest trees. Wherever the upper strata of the Pottsville conglomerate crop out all over these plateaus the soil is stony and not adapted to farming, but where the higher shales of the coal formation prevail there the soils are adapted to agriculture.

From Newton eastward toward Smethport where the shales prevail some farming, and successful farming, is being done. The valley of Potato Creek looking north and south from the hills above Smethport opens one of the most magnificent views of the agricultural sections of McKean county. The soils in this valley are composed largely of the rocks of the accompanying hills which have been disintegrated and broken up by glacial action and pushed down into the valley, and the alluvium brought down by the streams. At Smethport, Potato Creek and Marvin Creek flowing, the former from the south and the latter from the southwest, unite. Where these streams come together, the valley is much wider and a large section of creek bottom soils are formed, especially adapted to raising dairy crops, and hay or truck crops if a market for these is available.

North of Smethport at Farmersvalley, the valley of the creek again widens and another section of creek bottom and of moderately rolling hillside soils are formed in the manner already described except that it seems that the Catskill red shale takes more part in the formation of the soil. At Frisbee, in Eldred township, still further north, the valley of Potato Creek becomes still wider and a larger acreage of farming soils are formed in this valley. Not only is this the case, but the hills are lower because the Catskill shales become more predominant. Especially is this so south and north of Frisbee, in Eldred, and the southeastern part of Annin township.

The main section of Eldred township is the river valley which, in the southern and northern part of the township, covers well nigh the entire district and contains soils which are among the best for raising grasses in the northern section of the State.

CERES TOWNSHIP

Ceres township occupies the northeastern corner of the county. The northern section of this township is moderately rolling, with an elevation of only 1,443 at State Line Station, while the southern

section has an elevation of 2,245 feet above tide. The higher elevations are all in the Pocono formation while the Catskill and Chemung shales intermingle in the formation of the soils in the lower sections and produce splendid grass as well as all agricultural plants that will thrive here. A fossiliferous limestone. or limy shale, outcrops near Ceres, the effects of which show in the soils near by. The red soils in all these sections are productive. No coal shales occur in this township.

ANNIN TOWNSHIP

Annin township lies south of Ceres. It is more hilly and the hills are steeper along the streams. A few shales outcrop, but the greater part of the township is covered with Pocono sand. Some good apple and grass soils occur here. The elevations vary from 2,345 in the eastern section to 1,435 where Rock Run flows into the Allegheny River, a difference of 910 feet.

LIBERTY TOWNSHIP

Liberty township lies south of Annin. Port Allegany is the principal town. From this place northward and southward along the Allegheny River, are the best farming soils of the township. At Port Allegany the land of the river valley is quite level to the base of the hills, but is not too low for farming. The hillsides are not too steep for all farming operations to be carried on successfully. This soil produces well where it is farmed well. These hillsides do not wash until they have been abused by poor farming. A pasture can be maintained here for years by applying some manure and, occasionally, lime.

WARREN COUNTY

On the 12th of March, 1800, was passed the great New County Act by which Warren county was formed. It contains 577,280 acres, of which 254,321 is land in farms, and of which 112,025 acres is improved farm land. 9,260 acres were planted with corn in 1909, yielding 284,567 bushels; 14,515 acres were sown with oats, yielding 386,461 bushels; 4,100 acres were sown with wheat, yielding 65,435 bushels; 8,377 acres were sown with buckwheat, yielding 152,714 bushels; 157 acres were sown with rye, yielding 1,862 bushels; 2,745 acres were planted with potatoes, yielding 304,457 bushels; 41,010 acres were sown with all forage crops, yielding 39,297 tons of the various kinds of hay. Of the 112,025 acres of improved farm land, 80,164 acres were used for raising farm crops, while 31,861 acres were

not so used and were likely producing weeds. At this time Warren county had a population of 39,573 to feed, 26,023 cattle, 5,387 horses, 12 mules, 7,391 swine and 7,147 sheep.

The soils are derived from the Chemung flags, the oil sand formation of Venango county, the Crawford shales, the sub-Olean sandstones, Homewood sandstone, Connoquenessing sandstone, Olean conglomerate, including coal measures. The Chemung flags occur on both sides of the Allegheny River, in the northeastern corner, in parts of Corydon and Elk townships, and in Pine Grove township, along the Conewago River, and in Farming township, Fairbanks and Johnsons runs, and on Little Creek, in Freehold township, except where the glacial drift and the terminal Moraine materials predominate. The oil sand formation occurs along the lower levels of all the streams of the county, while the Crawford shales form the more or less elevated hillsides and the sub-Olean sandstones and overlying shales form the higher and rougher elevations, and the Homewood, the Connoquenessing sandstones and the Olean conglomerate and coal measures, form the plateaus, largely in the southern part of the county. The Allegheny River, which rises in McKean county, and flows into New York state, re-enters Pennsylvania in the northeastern corner of Warren county, flows south and west to Warren, where the Conewago River joins it, flowing in from the north, whence the Allegheny flows west to Irvinton, where the Brokenstraw empties into it from the northwest, and from whence the river changes its course southwest to Tidioute, where Tidioute Creek flows into it and thence south into Forest county. Caldwell Creek and its branches drain Eldred and Southwest townships. Tionesta Creek rises on the highest point in Watson township, overlooking the Allegheny River, and flows, within a few miles of that stream, northeast, directly opposite the flow of the river, to Cranberry Swamp, from whence it flows south and southwest, through Forest county, and enters the Allegheny River, all of which is accounted for by a dam of glacial drift having closed the valley between Cranberry Swamp and Warren, which also accounts for some of the topography of this section.

The county as a whole is hilly, covered with glacial drift in many places to great depth, which, wherever this is the case, forms the soils, except so far as the local rock strata have been acted on, by this glacial action and broken and ground up. The soils vary from the stony, gravelly, sandy and loamy uplands to the clay bottoms, any one of which may at times be underlaid with a pretty stiff hard pan.

SHEFFIELD TOWNSHIP

Sheffield township in the southeast corner of the county, except in the vicinity of Old Sheffield and between Sheffield Station and Tiona Station on the Philadelphia and Erie Railroad, is well nigh entirely made up of massive rocks of Olean conglomerate which makes a large part of it useless for agriculture. Kinzua Creek, where Corydon township begins, which, at Sugar Creek, Cornplanter and the town of Corydon, in the northern part of this township, has good farming lands, derived from the Chemung flags, Venango sands and glacial drifts, which, together, make soils of good agricultural capacity.

CHERRY GROVE, WATSON AND PLEASANT TOWNSHIPS

The soils are derived from the Crawford shales and the glacial drift, on the lower levels along the stream, and on the higher and rugged elevations from the Olean conglomerate and sandstone and where disintegration has gone far enough, some desirable soils are formed, but little farming is done and most of it poorly done, therefore the capacity of these soils are not known.

LIMESTONE TOWNSHIP

A large part of this township lies in the curve of the Allegheny River, and contains some agricultural soil along this stream; but the larger acreage and better soils are on the elevated portions, at such places as Kelly Hill, between the river and Hickory Creek. This plain on top of the hills begins in Forest county and runs beyond the Watson township line.

The soils are derived from the Olean sand shales and conglomerates and produce regular farm crops, in paying quantities, but they are especially adapted for potatoes and apples.

TRIUMPH TOWNSHIP

This township, located west of Limestone, on the Allegheny River, contains some good soils in such vicinities as Fagundus, and north and west of this place, and at Triumph and its vicinity, and at Tidioute, and north and east of this town, all composed of the same formation already described. Deerfield and Brokenstraw have some of the same elevated sandy soils as those described in Limestone township, but are rough and steep as at Garland Station, on the P. & B. In this vicinity a limestone formation occurs. More farming is beginning to be done here than formerly.

SOUTHWEST TOWNSHIP

Southwest township, west of Triumph, on the Crawford county line, has some desirable soils at such places as Enterprise and Scofield and the vicinities of these places, and along Caldwell Creek.

ELDRED TOWNSHIP

Eldred township, at Grand Valley and vicinity, has some agricultural soils especially adapted for the hay grasses. Some of the swampy soils of Rome township, Crawford county, come into Eldred township, which, when underdrained, make the best farming soils, especially for the hay grasses, such as timothy.

SPRING CREEK TOWNSHIP

This township lies north of Eldred and has a moderately rolling soil adapted to agricultural plants, especially the grasses. Corn yields well here.

GLADE AND PINE GROVE TOWNSHIPS

Glade and Pine Grove townships, in the northern portion of the county, are in the glaciated regions and the soils are formed by the glaciers and form the underlying rocks, such as the Crawford shales, and are not mountainous and rough, but rolling and well adapted for raising agricultural plants.

North, east, south and west of the city of Warren, especially at north Warren, these soils seem well adapted, when well treated, to market gardening. Following the Conewago Creek to Russell, the valley continues fertile and the soil gravelly, not difficult to plow and easily cultivated when plowed and put into condition for crops. From Russel to Akley conditions are about equally as favorable. At Irvinton where the Brokenstraw Creek enters the Allegheny River and where the river turns southwestward and the valley widens, the soils are richer and better adapted for intensive agriculture, such as market gardening. Here three townships come together, Pleasant, Brokenstraw and Conewago, and each one contains a portion of this better kind of soil.

FARMINGTON AND SUGAR GROVE TOWNSHIPS

Farmington and Sugar Grove townships are directly north of Conewango and are two of the most fertile townships in the county. These, together with Freehold, west of Sugar Grove and Columbus, west of Freehold and parts of Spring Creek and Pittsfield, south of the last two named, constitute largely the developed dairy and fruit section of the county. The localities at which the best practice along these lines has been followed are Sugar Grove and Chandlers Valley, in Sugar Grove township, at Lottsville, in Freehold township and Columbus, in Columbus township.

Evaporators are located at a number of these places. This is the country for the Northern Spy, the Greening, the Baldwin and the Jonathan apple when budded or grafted on York Imperial wood.

Grasses grow spontaneously here and there is a large acreage of land, from which the forest has been cut that is not farmed, that will furnish good pasture for sheep, young cattle and horses and should be used for this purpose. This land is moderately rolling, not too stony but just stony enough to prevent the soil from becoming very dry. Between Lottsville and Columbus are several swampy sections, which would furnish muck, which, if composed with lime or if applied to the soil, and the soils limed afterward would be a great benefit to these soils so deficient in organic matter.

Warren county is adapted for cool weather crops, such, among the cereal grains as rye, winter and spring wheat, oats, flint corn and buckwheat, and among the clovers, the Canada field pea, alsike and red clovers and alfalfa. It must not be expected that on soils, derived as are the soils of this county, largely from rock strata, deficient in lime and the alkali elements, which produce chemically active and productive soils, that as large crops can or will be produced here. But with a system of farming so arranged that these soils will at all times, have growing upon them a crop that will take up and hold in organic combination, the fertility as it is made available and at the same time gather in the sunlight, that fall in volumes, on the leaves of these and hold it for food, for man and animals and for soil building and with small applications of lime and commercial fertilizer, when necessary, but above all by the use of stable manure, crops not now equalled, on the naturally fertile soils of the State can be produced, especially apples.

ERIE COUNTY

This county occupies the northeastern corner of the State, with Lake Erie for its northern, the State of New York and Warren county for its eastern, Crawford county for its southern and the State of Ohio for its western boundary. The underlying rock strata, which outcrop and in a limited way, in connection with the glacial drift that take part in the formation of the soils, begin with the portage flags and ascend through the Girard and Chemung shales and the Catskill into the Pocono sandstone. The following, taken from the 2nd Geological survey of Penna., Vol. 10, page 49, gives an idea of the configuration of this county.

"A steep bluff of sand and clay from 50 to 100 feet high faces the lake through which break four large and numerous smaller streams from the highland. From the brow of this bluff, southward, the surface gradually rises to a height of 400 to 450 feet above the lake,

or 1,000 feet above tide. This escarpment then rises bodily to a summit line of 1,300 feet toward the west, and 1,500 feet toward the east, beyond which lie the uplands of the middle and southern townships at an elevation ranging from 1,400 to 1,700 feet above tide at the corner of New York.

The water in Lake Erie stood much higher at one time than now, because at Harbor Creek and at North East township four terraces occur, the highest beginning with 1,150 feet and descending as follows: To 1.070, to 875, to 795, to 765 and 740 feet above tide. The lowest terrace is a plain a mile wide and is covered with a lake deposit of brick clay. The second terrace is a broad sloping plain with an escarpment or lake beach, 40 feet high, running for a long distance parallel with the lake shore. At 1,070 feet above tide are remanents of a terrace covered with sand and detritus coarser than gravel, while the plain 1,150 feet above tide, three miles back from the lake, is destitute of such deposits.

The Pocono sandstone along the Crawford county line, on the divides in Wayne, LeBoeuf and Amity townships, take part in the formation of the soil. The Catskill or oil sand group spreads beneath the Pocono to the south and to the brow of the great escarpment on the north enters the formation of the soil. The Chemungs crop out along the upper escarpments and cover the broad flat valley of French and LeBoeuf creeks and in these sections shows its effects on the soils.

The following townships, beginning with the Ohio State line, front on Lake Erie, and have soils of similar derivation: Springfield, Girard, Fairview, Millcreek, Harborcreek and North East.

Erie county was judicially organized in 1803.

SPRINGFIELD TOWNSHIP

This township has Lake Erie for its northern and the Ohio State line for its western boundary. The southern part of the township is an elevated bluff, ranging from 860 to 900 feet above tide, which gradually declines northward to the lake shore bluffs, which rise only 625 feet above tide or about fifty feet above the surface of the lake. The soils are derived entirely from glacial drift. In the northeastern part of this township is a section of rolling upland, with deep, loamy soils, with fairly large water and rather poor fertility-holding capacity which, in the more gently rolling sections, is wet and cold, needing underdraining, but which, when underdrained, is the most productive land throughout this formation, adapted for raising hay, but which with the application of lime in the form of either the carbonate or the ground limestone or the caustic or the burned lime will produce the legumes such as alsike and red clovers on the lower sections and likely alfalfa on the more rolling upland. The Canada field pea or other varieties of northern grown peas

should do well here and these, together with alfalfa, clover, oats, barley, rye, buckwheat and linseed should make it possible, in connection with corn for silage and flint corn for grain, to produce about all that is needed for feeding a herd of dairy cows without the necessity of buying much if any concentrated feeding stuffs, while making it possible to improve the land at the same time. Apple trees grow thriftily and bear fairly large crops of well developed, fairly well colored, well flavored fruit.

Throughout the southern part of the township the soils are of the same derivation though not as well drained, and are rougher, and more stony, adapted for raising the same crops, except that the soils are older and probably more in need of lime, especially when the clovers above enumerated are to be raised. Throughout the central part of the township the soils are derived from the lake deposition and range from gravels to clays. These soils are usually well drained except in some low places where underdrainage would be needed. The soils of this township belong largely to the fine, sandy, warm, loamy early spring farming types and therefore are splendidly adapted for trucking because these crops can be planted earlier and when these soils contain organic matter derived from the clovers and from manure, rich in nitrogen, it becomes available quickly and crops grow fast and become marketable early so that on these lands the advantages of the higher prices of the early markets can be gotten.

Asparagus is one of the crops of which large yields of splendid quality can be produced early. Onions also produce large yields of splendid quality. Strawberries also come earlier and large yields of highly colored nicely flavored firuit is produced. Early potatoes yield splendid returns on these soils. The regular farm crops produced throughout this county thrive in these soils, especially alfalfa, Canada field peas, alsike clover and winter vetch, among the legumes, and oats, corn, wheat, barley, buckwheat and rye among the cereal grains, and it seems spring wheat should thrive well throughout this section and in these soils. Flax it seems should thrive on these soils and produce satisfactory returns only in the value of linseed if the flax were not used for the linen, because twenty bushels of flaxseed can be produced on an acre, which, where so large areas of land are not used at all, would be more profitable, than nothing except very ordinary pasture and little of it.

With such an array of crops adapted for these soils, a rotation can be arranged so that the soil improving and the soil exhausting crops can be made to interlock or overlap or follow each other so that the supply of organic matter, high in nitrogen, derived from these crops as well as from manure can be maintained in these soils up to such a standard that the crops previously enumerated can grow

thriftily and mature large yields early. Some of these soils are also used for raising grapes, but the grapes do not seem to produce as well neither are they of as fine quality as soils better adapted for their growth.

GIRARD TOWNSHIP

This township lies east of Springfield, with Lake Erie for its northern boundary. In the southeastern and the southern part of the township the soils are similar to those in southern Springfield, with similar capacities and adaptations. The surface is broken with streams descending from the higher elevations in deep channels. Along Elk Creek on both sides of the stream the soils are derived from materials from the washings from higher elevations and are either gravels or fine sandy loams as well as loams, and are usually deep, and where underlaid with fine clayey or fine sandy materials, are wet and cold, but when underdrained, are among the most productive soils throughout this county, especially when well supplied with organic matter of high quality. Throughout the larger part of the remainder of this township, except in the northern part, the soils are of the same derivation as those discussed in Springfield township, but instead of being fine sandy loams they are gravelly loams and are splendidly adapted for raising the crops there enumerated. In Springfield township they are especially adapted for raising alfalfa and winter vetch among the legumes, and rye among the cereal grains. These soils seem to be more especially adapted for raising grapes than for any agricultural or horticultural crops and the winter vetch both the organic matter so essential to maintain the soil in right physical condition as well as to supply it with the necessary quantity of fertility seems to be the plant especially adapted for this purpose. In the northern part of the township, except along Elk Creek, the gravelly soils prevail with similar capacities and adaptations previously discussed.

FAIRVIEW TOWNSHIP

This township lies east of Girard along Lake Erie. The southern and central parts of the township have soils derived from the glacial material brought from higher elevations as well as from that ground up and disintegrated in place.

This section is hilly and rolling, with fairly deep soils, with limited water and fertility holding capacity, very deficient in lime as well as organic matter, both of which must be supplied before crop yields will come up to the normal capacity of these soils. The pasture grasses, especially red top, thrives well here wherever lime has not been applied; but where lime is applied timothy and blue grass and the legumes soon take the place of red top. Through the central part of this township passes a divide 950 feet above tide, along

which the rocks from which the soils along the lower hillsides and the lowlands are largely derived outcrop so that these soils are very similar to the rock from which they originated, the Catskill, and are fertile. In the northern part of the township the soils are of similar origin as those of the township previously discussed, much of it of the gravelly, sandy types, easily farmed, with sufficient water and fertility holding capacity to carry crops through a normally dry season adapted for raising the legumes among which are alfalfa, red and alsike clovers and the crops previously referred to.

MILL CREEK TOWNSHIP

Millcreek township lies northeast of Fairview, along the shores of Lake Erie. An upland plain extends north and south through this entire township with soils derived from glacial material and produced by glacial grinding, which are comparatively deep with rather limited water and fertility holding capacity which, when sufficient organic matter is present will hold enough water to produce and ripen fairly large crops of the hay grasses, oats, buckwheat and potatoes, and with lime, could be made to produce large crops of alfalfa. The southern part of the township has similar soils of similar origin as those previously discussed. In the northern part the soils are derived from the same source as those of Fairview and Girard, with a larger area of soils adapted for grape culture, especially west of Erie, the county seat of this county, which is located in this township. Much of the land throughout this northern section is adapted for raising truck crops and the berries, and should be devoted to raising these crops because of the splendid market afforded by the city of Erie and the towns in the immediate vicinity. These soils will also produce large yields of the crops needed for feeding the dairy herd.

HARBOR CREEK TOWNSHIP

This township lies northeast of Millcreek, also along the shore of Lake Erie. The soils are similar in derivation. The land rises in a moderate slope from the Lake Erie bluffs for a distance of two of more miles to the foot hills. The soils of this section are derived from lake deposits and are similar to those previously discussed. A considerable area in the central and northeastern section is especially adapted for raising grapes; small fruits and truck crops also find congenial soil and climatic environments throughout this part of the township. Above the hills, referred to, another level space, 1,700 feet above tide, with gravelly and sandy soils, derived from the underlying rock and glacial deposits are adapted for raising the grasses. South of this section are several swampy areas, that

could be drained and some of the best land of the section made to produce large crops. Otherwise the soils are of similar origin capacity and adaptation as those previously discussed.

NORTH EAST TOWNSHIP

This township occupies the northeastern corner of this county, bordering the shores of Lake Erie on the north and the State of New York on the east. The southern, but more particularly the southeastern part of this township, lies within the area of soils derived from the underlying rock and the glacial materials very similar to the soils previously discussed. The divide between French Creek and the lake streams passes through and just south of this section. The soils of the northern and eastern part of the township are derived from the lake deposits, and belong largely to the gravelly loams and to the gravels and as previously indicated are adapted for raising the regular farm crops such as will thrive under prevailing climatic conditions when a sufficient quantity of organic matter is maintained in the soil. A larger area of soils throughout this township is adapted for grape growing than any township in the county, and much more of this land should be used for the production of this fruit, because larger returns could be realized from this source, and by raising the soil improving crops, the productive capacity of this land could be maintained and likely improve as time goes on.

Conneaut, Elk Creek and Franklin townships have soils derived from similar sources, except the northern part of Franklin.

CONNEAUT TOWNSHIP

This township occupies the southwestern corner of this county, with the Ohio State line for its western and Springfield township for its northern and Crawford county for its southern boundary. The soils are nearly wholly derived from drift materials which so completely buries all the underlying rock, that barely any of the streams have cut down into them, therefore they have little effect on the soil. These soils are loamy, so compacted that water does not so readily penetrate into them and consequently they seem wet in the lower sections and are very much benefited by underdraining. These soils are deficient in lime, both in the sources from which they are derived and because of their formation and lime as the carbonate or the caustic benefits them very much. With lime and underdrainage these soils will produce twice what they are now producing, because the clovers will then grow and the soil improving crops can be raised and rotations established or worked out by means of which larger yields can be obtained and the soil improved. On the

higher elevations or the well drained areas apple trees make a thrifty growth and produce large crops of well developed, nicely colored, well flavored fiuit. Such soil improving crops, as experience will demonstrate, are best suited to maintain the soils in conditions to produce and ripen such a wood growth that will yield the largest crops of well developed, nicely colored and flavored fruit annually should be raised. In the northern and eastern part of the township the soils are more clayey, with some rougher sections, all of which usually need underdrainage, and such treatment, with lime and crop rotation, as the soils previously discussed.

ELK CREEK TOWNSHIP

Elk Creek township lies east of Conneaut, along the line of Crawford county. The soils are of similar derivation as those of the township previously discussed, except that in the more elevated sections the underlying rock takes greater part in the formation of the soil than in Conneaut township and makes a more stony and sometimes rocky, thinner and more difficult farming land especially adapted for raising the hay and pasture grasses which can be enormously improved by putting the land in condition to raise clovers by the use of lime and by growing such crops as can be plowed down for the purpose of getting organic matter into the soils.

FRANKLIN TOWNSHIP

This township lies east of Elk Creek and Girard, on the divide between Elk Creek and Lake Erie, and the land is, therefore, higher and more gravelly. The soils of the southern part of the township are similar to those of Elk Creek and those of the northern part similar to those of southern Girard, in connection with which they have been discussed, except that in the central part of the township is a section of apple soils similar to those discussed in Conneaut township, which should be used for raising this fruit and should be handled in the way suggested under that township.

WASHINGTON TOWNSHIP

Washington township lies directly east of Franklin and Elk Creek, on the Crawford county line. The Catskill or oil sand group underlies well nigh the whole township; but the valleys are so filled with drift materials, especially in the southeastern part, that the underlying rock does not come to the surface. The soils are sandy, loamy and clayey from the drift material, much of them needing underdraining. This is especially the case in the vicinity of Con neaut Lake, which seems to be an expansion of Conneaut Creek into a lake or broad sheet of water. The streams are sluggish and the

land generally wet, needing underdraining and liming. The remainder of this township is moderately rolling, some hilly, with deep soils along the lower slopes of the hillsides, while along the higher elevations the soil is not as deep and is more stony and more difficult to farm. These soils, as previously indicated, will produce the hay grasses, red top, where no lime has been applied and timothy and clover, where liming has been done. The deeper soils will also produce alfalfa and the short season clovers such as the Canada field pea and the winter vetch.

McKEAN TOWNSHIP

This township lies east of Franklin and Fairview, north of Washington and south of Mill Creek. In the southern part of the township the surface rises 1,500 feet above tide. The Chemung flags make the surface rock over all but the southern part of the township and, therefore, the soils are not as fertile as those derived more largely from the Catskill and the glacial drifts. It seems that rye, oats, buckwheat and flax, with such soil improving crops, as the winter vetch and alfalfa, the alfalfa on the deeper soils and the vetch and the Canada field peas on the thinner types should do well both for supplying organic matter of a superior order and to furnish nitrogen.

It must be remembered that even with the wonderful hunger that these soils have for organic matter that they cannot consume the amount that similar soils would consume in a longer growing season. The organisms that effect decomposition of the organic matter become inactive as soon as the weather becomes too cold for plants to grow and therefore a much smaller quantity of organic matter will be required in these sandy and loamy soils in Erie county than would be required in similar sandy and loamy soils in Delaware county this State.

Summit, Greene, Greenfield, the larger parts of Venango and Amity townships have soils derived from similar sources in so far as the underlying rocks enter into the formation of the soils. The oil sand group and the Chemung flags are the strata from which, together with the glacial drift, the soils of the higher elevations are derived while along some of the lower sections, the Chemungs might enter the soils.

SUMMIT TOWNSHIP

Summit township lies northeast of McKean and south of Mill Creek. It forms the divide betkeen LeBoeuf Creek and Lake Erie; the elevations varying from 1,300 to 1,400 feet above tide. The soils, except along LeBoeuf Creek in the eastern part of the township are of the fine loamy type and are usually deep, with such a water and fertility holding capacity, that with good cultivation, when the fer-

titlity is largely contained in organic combinations, as that derived from winter vetch, crimson clover, manure and heavy sods plowed down and is made available by the agencies of decomposition, with a growing plant on the soil to take up the fertility as it is made available, usually produce splendid returns. Such crops as potatoes, on the more sandy and rolling sections, Canada field peas and oats, buckwheat, rye and it seems spring wheat and flax will do well on well nigh all of these soils with such legumes as the winter vetch, the Canada field pea, the crimson clover, among the annuals, and alfalfa and alsike, among the long season, to maintain fertility and improve the physical condition of these soils. It seems only reasonable that in so far as possible the fertility used with the regular farm crops should be in organic combination in this soil so that it may be made available as the plant needs it, and that there may be as little loss as possible. The sections of these soils which have good air and soil drainage are splendidly adapted for raising apples. The trees will make a thrifty vigorous growth where the supply of a superior organic matter is kept up in the soil and will yield large crops of well developed, well colored and flavored fruit. This industry should be developed throughout this section, and such a series of soil improving crops should be grown as will provide the nitrogen needed by these trees to produce and ripen a wood growth of sufficient vigor to maintain the annual bearing capacity by these trees, of large crops of well developed highly colored, nicely flavored fruit for the longest time. It seems that finely ground unacidulated phosphatic rock applied with the manure to these soils should produce splendid results. In the eastern part of this township is a swampy area which if drained would probably make a splendid onion and celery raising section as about all the mucky areas would throughout this county if drained, thus opening up large areas especially for raising these crops.

GREENE TOWNSHIP

This township lies east of Summit and south of Harbor Creek. What has been said in regard to the capacity and adaptation of the soils of Summit township, applies equally to Greene township and, therefore, need no further discussion here.

VENANGO TOWNSHIP

Venango township lies south of Greenfield and east of Greene on the New York State line. The soils of this township are of similar derivation as those of Summit, and the township above referred to, except that the hills are planed down more than those of Summit and many sections of the other townships, and the soils along the

hillsides are deeper and can probably be made with good agricultural practice to yield larger crops than the soils of the previously discussed townships.

Through the center of this township, along French Creek, where gravelly loams and gravelly as well as sandy soils occur, of which those above the overflow of the streams are adapted for raising the regular farm crops such at oats, corn and it seems wheat especially, spring wheat, among the cereal grains, and among the legumes, alfalfa, alsike and red clovers and the Canada field pea. It seems this should be a splendid soil for raising the Canada field pea seed for which there will be a larger demand as time goes on. In the southwestern corner of this township another area of these soils occur.

AMITY TOWNSHIP

This township lies south of Venango. Soils of similar derivation, capacity and adaptation occur in this township, as those of Venango, except along the southern border, which will be discussed in connection with the southern townships.

WAYNE AND CONCORD TOWNSHIPS

Wayne township lies east of Amity, with the New York State line for its northern, and the Warren county line for its eastern boundary. The soils of the township are derived from the oil sands and glacial materials. In the northeastern part of the township, the soils are largely a sandy loam, many sections needing underdrainage, while others sufficiently elevated, with enough gravel mixed with the subsoil which in extremely wet seasons when these soils become water-logged and crops suffer do not need it. These soils, as those of the same type previously discussed, should be well supplied with organic matter, derived from the clovers and with carbonate of lime. The same soils occur in the southeastern part and along the southern border to the middle of the south township line.

These soils, in their present condition, produce fairly large crops of timothy and red top hay with, however, little clover until limed, and with the use of lime, the clover begins to thrive and the crops of timothy hay increase and red top largely disappears. It seems that rye and the winter vetch should be raised together as soil improving crops or might even be harvested for hay or silage and the ground planted with corn or one of the late varieties of peas, and another crop of a high quality roughage raised and with the peas, the land seeded with one of the clovers likely alsike, and timothy.

A timothy and clover or alfalfa sod can be started in these soils with or in the corn raised for silage and a splendid crop of hay raised the following year. It seems that this method would make it

possible for the farmers to produce much larger crops and feed a larger number of animals than are now fed and at the same time improve their land. In the central and northwestern part of this township the soils are similar to those of Venango township previously discussed.

CONCORD TOWNSHIP

This township occupies the southeastern corner of this county with the Warren county line for its eastern and the Crawford county line for its southern boundary. The soils of this township are similar to those of Wayne to the north, except that south of Corry is the highest ridge in Erie county ranging above 1,800 feet and more above tide. In the southeastern corner of the township is a swamp with a more gravelly and sandy soil than the swamps previously referred to and not likely adapted for raising crops. French Creek flows in a drift filled valley from one to two miles wide, with gravelly, sandy, loamy and clayey soils, derived from this drift material adapted for the raising of similar crops previously discussed.

Union, LeBoeuf and southern Waterford townships have soils so similar that they can be discussed together.

Union township lies west of Concord on the Crawford county line. French Creek flows through both these townships in a wide drift filled valley, with fairly fertile soils of the same character as those of Concord township, with similar capacities and adaptations.

Tamarack Swamp, located in the northeastern part of Waterford township, which lies north of LeBoeuf and the southeastern part of McKean township, has soils similar to the soils of swamps previously described. The soils of the other sections are of similar derivation, capacity and adaptation as the sandy, loamy and clayey types derived from the drift and underlying rock of previously described townships.

CAMERON COUNTY

Cameron county, named for the Hon. Simon Cameron, was organized March 29, 1860, from parts of Clinton, Elk, McKean and Potter counties. It contains 250,880 acres, of which 34,748 acres is land in farms and of which 10,869 is improved farm land. 519 acres were planted in corn in 1909, yielding 13,826 bushels; 623 acres were sown with oats, yielding 13,425 bushels; 31 acres with wheat, yielding 341 bushels; 558 acres with buckwheat, yielding 8,330 bushels; 18 acres with rye, yielding 207 bushels; 481 acres were planted with potatoes, yielding 33,046 bushels; 3,411 acres were sown with all forage crops, yielding 3,892 tons of various kinds of hay. Of the

10,869 acres of improved farm land, 5,641 were used for raising crops, while 5,228 were not so used and were likely producing weeds. At this time Cameron county had a population of 7,644 people to feed, 1,563 cattle, 461 horses, 4 mules, 445 swine and 581 sheep.

SOIL FORMATION

The soils are derived from the Chemung shales, in the valleys and the lower hillsides of Beech Creek, West Creek and the Sinnemahoning, at Emporium. Besides this the floors of the remainder of the valleys of the streams draining the county, such as Bennetts Branch, Stirling Run, First Fork and others, are formed of Catskill, while the hillside and hilltops soils are made of Mauch Chunk red shale, the combination of conglomerate and sandstones and the coal sands and shales and coal measures in the southeastern section of Shippen township in which Emporium, the county seat, is located.

Gibson township, in the southern part of the county, has some agricultural soils along the Karthaus and Lincoln Roads, and along the Sinnemahoning and Bennetts Branch, Wycoff Run, and on the hills above and along the more moderately sloping sides of the valleys.

Lumber township, in the central part of the county, contains some of the best agricultural soils at such places as Sterling Run, and in the vicinity of Cameron, because north and west of this place the Cameron bituminous coal basin is located and it carries with it the calcareous coal shales which make good agricultural soils. These places are hilly but can be farmed.

Portage township, north of Lumber, is largely within the valley of the Sinnemahoning, and at such places as Sizerville, contains good farming lands, especially on the hills east of Emporium and the hillsides at Sizerville.

SHIPPEN TOWNSHIP

Some farming is done in this township on More Hill, in the sandstone formations, and such crops as buckwheat and potatoes, which seems to be the main money crop of the farmers, yield good results. On Bryan Hill, a little east of More Hill, the Mauch Chunk red shale forms the soil, and it, with the coal shales that have come from the higher elevations, make soils that produce the average farm crops which thrive under these climatic conditions, such as oats, potatoes, buckwheat, and rye, which does especially well, and also garden crops, such as tomatoes and cabbages in the lower places. Timothy, orchard grass, Kentucky blue grass and the clovers thrive so well that wherever seed is dropped as has been the case where these hays were fed in lumbering camps, these grasses and

clovers continue growing years after the first seeds had been brought with the hay. Whitmore Hill on the same formation, northeast of More Hill, overlooking the West Creek Valley, is another of the farming districts of the county, where fruit does well and where such crops as potatoes, buckwheat, rye, oats, and it seems Canada field peas and oats, would thrive. Flint corn will do well here under careful cultivation. Further west in the same township, at Beechwood, on West Creek, are some good small farms in the valley with alluvial soils adapted to market gardening and trucking.

GROVE TOWNSHIP

Grove township, in the eastern part of the county, along the First Fork Creek, contains some agricultural soils; but the greater part of this township should be reforested where the forests have been cut away as is the case with the greater part of it. Rich Valley further north in the same township is carved out of the mountains of the formations, already described, by the Driftwood Branch and its tributaries and contains one of the best farming sections of the county. Here, considerable dairying is done, for which the soils are adapted, because forage crops such as timothy, clovers, oats and short season varieties of corn thrive, and with careful attention, larger crops than are now produced can be obtained. The valley widens wherever tributaries flow into the Driftwood, and a larger acreage of farming land is available. On the hills between West Creek and Driftwood, are farming soils on which some farming is being done. But much more could be done, especially in the northwest corner, along the Elk and McKean county lines, because here the coal shales prevail and form agricultural soils. Many of these hills and mountains, which at one time were covered with the most magnificent forest that ever grew on any such hills, have been burned over so many times that trees will no longer grow because their seeds and the vitality of the roots, together with the organic mulch that protected these and conserved the moisture for the germination of seeds and sprouting of roots, have been destroyed. Several more burnings will start a destructive operation unequalled in its effects by anything that has yet happened in this State, not only with the soils of these hills and mountains, but also that of the narrow valleys, which will be covered over with stones and rocks and the courses of the streams changed and the operatives of the industries located here will look out on the gully riven hillsides and the rock and stone bestrewn valleys, with neither trees nor other vestiges of vegetation. This is not a freak of fancy; the process has started in a small way now. It seems that the trained engineers, who manage the railroad systems traversing this region, should see this and stop the setting on fire of these hills and mountains. This is the most important farming here.

ELK COUNTY

In the spring of 1843 a bill was passed creating the county of Elk from portions of Jefferson, McKean and Clearfield counties. It contains 515,840 acres, of which 76,032 acres is land in farms, and of which 34,872 acres is improved farm land. 1,064 acres were planted in corn in 1909, yielding 23,870 bushels; 4,472 acres were sown with oats, yielding 116,926 bushels; 187 acres with wheat, yielding 3,325 bushels; 1,279 acres with buckwheat, yielding 18,436 bushels; 239 acres with rye, yielding 4,106 bushels; 1,439 acres were planted with potatoes, yielding 136,180 bushels; 13,350 acres were sown with all forage crops, yielding 14,696 tons of the various kinds of hay. Of the 34,872 acres of improved farm land, 22,030 were used for raising farm crops, while 12,842 were not so used and were likely producing weeds. At this time Elk county had a population of 35,871 to feed, 6,629 cattle, 1,580 horses, 15 mules, 2,972 swine and 456 sheep.

SOIL FORMATION

The outcropping rocks from which the soils of Elk county are derived, begin, according to the Second Geological Survey of Pennsylvania, with Catskill sand, which is brought up on North Fork Creek, near North Fork Summit, but nowhere enters into the composition of the soils except, probably, in this narrow valley. The Pocono sandstone follows the Catskill a little higher, geologically, in all the valleys of the streams, followed by the Mauch Chunk red shale which, however, is not red but is a shaly formation belonging to these strata. More extensive than all the above strata combined, are the Olean conglomerates, Marshburg coal and the Kinzua Creek sandstone, members of the Pottsville conglomerate formation; while still more extensive than all previously named formations are the members of the lower productive coal measures, with a few isolated exceptions, geologically, the highest formations of the county.

According to the U. S. Geological Survey, Elk county has but two formations, the Allegheny and Pottsville, which include all of those mentioned in the Pennsylvania Survey.

BENEZETTE TOWNSHIP

Benezette township, located in the southeastern corner of the county, is drained by the Bennetts Branch of the Susquehanna River, and its branches, Hicks, Dents, Trout, Mix and Meadic Runs, and by Mosquito Creek, flowing into Clearfield county. The rock of the southeastern section belong to the Pottsville conglomerate and the lower coal measures.

The soils of the southeastern section of this township are derived from members of the Pottsville conglomerate, such as the Olean conglomerate and the Kinzua Creek sand, and in this whole section, the

hills though with broader and more rolling tops than in the central and northwestern section of the township are not as fertile and do not respond to good agricultural treatment as do the hilltops of the central and western sections. All of this section has been and would be covered with forests had it not been burned over and over until extensive areas no longer grow forest trees. Northwest of the Bennetts Branch, the Mahoning sand remains on the highest hilltops, west and southwest of Benezette, and below these the lower productive coal measures compose the soils and here, as elsewhere, make a more fertile and productive soil than the members of the Pottsville. But the country is so hilly that it is not feasible to engage in regular farming operations even though the soils are normally fertile. On the road northeast from Bennetts, along the summit, the ferriferous limestone is exposed and has been quarried and burned for lime. This stone is so located and of such quality, and occurs in such quantity, that the entire surrounding country could be supplied with lime, so much needed by most of these soils especially, the Pottsville. All these more fertile soils are located in what is termed the third Cameron coal basin or wherever the coal, coal shales and the ferriferous limestone and the disintegrated remanents of these still exist.

JAY TOWNSHIP

Jay township lies directly west of Benezette. The third coal basin occupies the entire central section and, therefore, to some degree, at least, better soils exist in this section because formed by the disintegration of these rocks. These coal formations being more easily eroded than the underlying rock produces scalloped hillsides and beautiful scenery.

The ferriferous limestone is exposed along the Caledonia Run, in two strata. The following analyses give the composition of this limestone, which are numbered 9 and 10, Second Geological Survey. R. R., page 275.

	9	10
Carbonate of lime, ...	66.91	36.76
Carbonate of magnesia, ...	9.83	2.01
Insoluble residue, ...	16.13	53.33
Phosphorus, ...	.07	.03
Sulphur, ...	.01	traces

This central section of the township, as already stated, has the best soils, but in the northwestern section, along the eastern slope of Boon Mountain, are the best fruit soils in this county. Here the conglomerate and coal shales combine to form the soil. North and northeast of Horse Shoe Bend are elevated rolling sections of a disintegrated rock of the conglomerate series and lower coal measures which are

deep, on which fruit, especially apples, grow without special fertilization. Such are the reports of those who have known the section for a long time. These soils extend beyond the northern limits of this township into Benzinger township, and southwest into Clearfield county, and Snyder township, Jefferson county.

A large part of Jay township should be in forest, and would be, were it not for the perennial burning. The streams, draining this township, are Trout Run, Spring Run, Little Wolf Lick, Wolf Lick and Windfall Run, all flowing into Trout Run, which flows into Bennetts Branch. Bell Run, Caledonia Run, Kersey Run and Cherry Run complete the system.

FOX TOWNSHIP

Fox township, directly west of Jay has soils derived from similar rock formations, and in many instances are very much alike. Boon Mountain, already referred to in the discussion of Jay township, is a ridge capped with members of the Pottsville conglomerate rock. It traverses the entire southeastern section of the township. The valleys of the eastern slope of this mountain are very steep, because here the underlying Pocono sandstone becomes more of a flag stone, is more easily disintegrated than where it is sandy, while the Pottsville conglomerate, the rocks capping the mountain, especially the underlying strata, do not so readily disintegrate, therefore, the steep hillsides and deep valleys and the uplands are hard to get to, making some places inaccessible. Here the fruit soils, already referred to, are located in the well disintegrated patches of the lower coal measures. West of Boon Mountain the lower coal formations prevail, because a trough or a gradual sloping of rock strata from Boon Mountain, westward, is of such extent that these coal formations very much higher, geologically, are here lower in position than Boon Mountain and give to the soils their good qualities. Here on some of the hills are members of the Mahoning sandstone, and remains of the Upper Freeport limestone are common, as well as those of the Lower Freeport down to the ferriferous limestone, which is the most extensive in this township, occurring a considerable distance northwest of Centerville, southwest, into Kylers Corners and along Toby Run, beyond the limits of the township, into Horton township where a further discussion is given.

HORTON TOWNSHIP

Horton township lies directly west of Fox and extends further south between the territories of Jefferson and Clearfield counties than do the other southern townships of this county. This township lies almost entirely within the limits of the coal basin, already referred to. Boon Mountain crosses its southeastern corner, and what might be called the Ridgway hills. Toby Creek drains well nigh

the entire township. The elevation above tide are usually high as they are in the other sections of the county, varying in this township between 1,442 feet on Toby Creek, on the Jefferson county line, and 2,166 feet at Boot Jack, in Ridgway township, just across the northwestern corner. The southeastern corner of the township is in the Boon Mountain and contains some of the soils already described along this mountain in Fox and Jay townships. The Mahoning sandstone remains on most of the higher summits along the valleys of Mead, Oyster and Johnsons Runs.

The soils below the Mahoning which here consists of a grey and yellow shale is of better quality than the Mahoning usually is, and it with coal shales which enter into the formation of the soil show their good effects in the soil they form. The Upper Freeport limestone, one of the desirable members of the lower productive coal measures, occurs on Toby Creek which, according to an analysis reported in volume R. R. P. II Second Pennsylvania Geological Survey, page 232, has the following composition:

Carbonate of lime, ...	80.35
Carbonate of magnesia, ...	1.61
Oxide of iron and alumina, ...	3.61
Phosphorus, ...	.08
Insoluble residue, ...	12.29

This limestone seems to be replaced by shales in some instances. The Lower Freeport limestone formation also occurs in this section along Mead Run, a branch of Toby Creek.

Samples from three localities, according to analyses published on page 235 of the report already referred to, have the following composition:

Carbonate of lime, ...	69.35	57.32	81.87
Carbonate of magnesia, ...	9.30	8.85	7.18
Oxide of iron and alumina, ..	4.83	7.94	2.75
Insoluble residue, ...	13.68	21.25	6.54

These limestone seams and the two Freeport coal seams frequently occur so close together—in this case only from five to ten feet apart and at such an elevation, 1,650 feet, that the lime can, with the coal so close at hand, be burned on the hills and the lime spread from the hillside down and on top of the lower hills where, if the sandy formations of the coal measures prevail, the soils is usually in need of lime. Another limestone seam known as the Johnstown cement bed, occurs in these hills. This bed was not visited, and what is said here is taken from the report of the Geological Survey, Volume R. R., page 237. This limestone occurs in what is known

at the Kittanning group, on J. McAllister's farm, 20 feet above the middle Kittanning coal bed and has a thickness of four feet and has the following composition according to an analyses by A. S. McCreath:

Carbonate of lime,	80.35
Carbonate of magnesia,	1.61
Oxide of iron and alumina,	3.61
Phosphorus,	.08
Insoluble residue,	12.29

Still another limestone formation occurs in this township, the ferriferous, so frequently referred to in these reports. Along the side of the road east of Brockport, this limestone has been quarried from a vein about seven feet thick with an opening about fifty feet long.

Not only do these limestones enter into the composition of the soils, but limy shales occur with them and add beneficial ingredients. All this makes good farming land where such formations enter into the composition of the soil, but it must be remembered that these lands are hilly and it is difficult to work them and equally difficult to get crops when raised down off the hills.

BENZINGER TOWNSHIP

Benzinger township lies directly north of Fox and Jay townships, and the largest part of its territory is occupied by what is known as the St. Mary's coal basin, which extends from Boon Mountain on the southeast to the conglomerate hills on the northwest and from Laurel Run on the south to North Fork Summit on the north. The Freeport limestone seams do not occur in this township, neither has the Johnstown cement bed been discovered, but the ferriferous limestone occurs on the hills about St. Mary's in isolated places. An examination of a mine from which this limestone was being mined and burned into lime was made near the town of St. Mary's and it was found that it makes a high grade of agricultural lime, which in this vicinity, can be put on the market at a very reasonable price on account of the close proximity of the lower Kittanning coal bed, which is mined only a short distance from the limestone and used for burning the lime. Only two limestone formations have been found in the Kittanning coal group, the Johnstown cement bed and the formation of the soils. The shales, and sandstones of this coal group largely make the soils of this township, some of which are quite fertile; but wherever the sandstone becomes massive and where

disintegration has not proceeded far enough to convert the sands and shales into gravelly and loamy soils, but where these strata come too close to the surface, the soils become dry and crops do not thrive as is the case wherever such conditions prevail; but no large sections of such soils occur. The hilltops usually have a gravelly soil, formed by the breaking up or disintegrating of sandy shales. The valley soils of this section are used to a considerable extent for trucking, and with good treatment, results are obtained not surpassed in many sections with soil derived from superior materials. A hard pan occurs in some of these formations, usually below the lower Kittanning coal seam, made up of an iron formation which is usually down about three feet, and well nigh impervious.

RIDGWAY TOWNSHIP

Ridgway township, in which Ridgway, the county seat of Elk county is located, lies north of Horton. It does not contain as rich a soil inheritance. Along the Warren and Ridgway Pikes, about six miles northwest of Ridgway, is the Montmorency farm, a tract of several hundred acres, which has been farmed for a long time. It has been demonstrated here, by liming and the application of manure and by good agricultural practice, what these soils are capable of doing. Between Ridgway and this farm are a number of good farms capable of producing twice as much as they are now producing. A large acreage of these farms needs underdrainage to make the soil capable of producing up to its capacity. This would require a drainage system of considerable extent and should be done by the township, county, or the State, or by uniting those interested, and undertaking the project in this way. The soils that need underdrainage here are mucky and will make the best soils in this section when drained. Nearly all of this township, especially the northwestern section, lies within the fifth bituminous coal basin and its soils contain the coal shales and sandstones, together with the conglomerates, having a thickness of several hundred feet. The Clarion River flows in a tortuous course from the northeastern to the southwestern corner, with, in many places, steep hillsides, with little farming land along its course. Some farming is done at Whistleton, some on the hills about Johnsonburg, Wilcox and some other sections, but the farms are usually small.

JONES TOWNSHIP

Jones township lies on the northern and eastern border of the county. The farming lands of this township lie nearly at the southwestern corner, north of Montmorency farms, along the Warren Pike, and in the north central section, northeast of Wilcox, through Pistner Hill, on to Williamsville or Rasselas P. O. This whole section lies

again in a coal formaiton known as the fifth bituminous coal basin and its soils are derived from the coal shales, sandstones, shales and the ferriferous limestone, which makes it one of the farming sections of the county.

The limestone formation in the General Kane quarry—which name is retained here because no more widely recognized name is known—near Pistner's Hill or in the Pistner's Hill section, contains a rotten upper limestone seam, with a gray shale and iron ore several feet thick between it and the lower blue limestone which here is from five to ten feet thick.

The following analyses represents the composition of the upper and lower strata:

	Upper bed	Lower bed
Carbonate of lime,	94.35	94.10
Carbonate of magnesia,	1.63	1.36
Oxide of iron and alumina,	1.63	1.62
Phosphorus,	.03	.06
Silicious matter,	1.63	2.20

It is probable that the entire Pistner's Hill section is underlaid with this limestone covering a considerable territory. In the southern section of the county, already referred to, this limestone crops out on the surface along the road and here as on the hills about St. Mary's it has been grupped out for liming purposes.

Another limestone in the Pocono formation crops out along Straight Creek in the northeastern section of the county. This section was not visited and, therefore, we have to take only what could be gotten from heresay, which reports the vein about four feet thick.

The remaining sections of this county are hilly, stony, and rocky except where the upland plains of the conglomerate formation occur which, with good agricultural practice, would, in many places as has been demonstrated in Highland and Spring Creek townships, produce paying crops. More could be done in Highland township than has been because the big or forty mile level passes through this township, and here, as in McKean county, already referred to, it forms an elevated level section of land, in many places free from stone and splendidly adapted for grazing and the production of forage crops.

FOREST COUNTY

Forest county was first organized from parts of Jefferson and Venango counties, April 11, 1848; but more land was added to the county in 1866. It contains 270,720 acres, of which 49,221 acres is

land in farms, and of which 20,241 acres is improved farm land. 1,077 acres were planted in corn in 1909, yielding 38,000 bushels; 2,419 acres were sown with oats, yielding 57,335 bushels; 426 acres were sown with wheat, yielding 7,249 bushels; 1,253 acres were sown with buckwheat, yielding 18,445 bushels; 112 acres were sown with rye, yielding 1,519 bushels. 565 acres were planted with potatoes, yielding 56,376 bushels; 6,306 acres were sown with all forage crops, yielding 6,244 tons of the various kinds of hay. Of the 20,241 acres of improved farm land, 12,158 were used for raising farm crops, while 8,083 were not so used and were likely producing weeds. At this time Forest county had a population of 9,435 to feed, 2,672 cattle, 857 horses, 6 mules, 1,212 swine and 1,027 sheep.

Forest county lies south of Warren, east of Venango, north of Clarion and Jefferson and west of Elk.

The Pocono sand and the Mauch Chunk shale crop out in the valleys of the streams, which are usually narrow and contain narrow strips of agricultural land on either side, with an occasional widening, as at Tionesta, where Tionesta Creek and Hunters Run flow into the Allegheny River. All the uplands soils are made up of the disintegrated formations which, in this county, constitute the Pottsville conglomerate, made up of the Johnson Run sandstone, the Alton coal group, the Kinzua Creek sandstones, Marshburg coal and Olean conglomerate. These form a soil of somewhat variegated fertility as the following observations of the various townships will show.

The drainage of the county is accomplished by the Allegheny River and its tributaries, such as Hemlock Creek, the Little Tionesta, flowing from the south, Hunters Run and West Hickory Creek, flowing from the west, Hickory Creek, Tubbs Run, Tionesta Creek, from the east and the Clarion River, which forms the southern border, with its tributaries flowing southwest.

HICKORY TOWNSHIP

Hickory township lies north of Kingsley and Tionesta, on the Warren county line. The soils of this township are derived from the conglomerates, largely the Olean, on the high elevations and the Pocono along the streams. The hillsides along the streams are usually so steep that no farming can be done. On the divide between Tionesta, Hickory Creek and the Allegheny River are soils similar in formation to those in Dutch Settlement or on Dutch Hill, with the exception that there are less of the shaly sandy formation and more of the sandy and stony types. Apple trees look thrifty but only those growing wild were noticed.

KINGSLEY TOWNSHIP

This township lies directly north of Green and, as already stated, its soils, with the exception of the valleys of the Tionesta, are derived from the components of the Pottsville conglomerate which. in this case, are the best soils I have found made up of this formation.

The soil formation of German or Copps Hill Settlement extends into this township, and at such places as Wicks Hill, where the Camp Meeting Grounds are located, forms, on the higher levels, a loamy and a little higher, a gravelly soil of fine character which produces a superior grade of potatoes, is well adapted for oats, timothy, wheat, buckwheat, clover including alfalfa.

Apple trees look thrifty and bear well; cabbages and rape do very well, especially on the better grade of these soils. The sandy formation, which is usually a little below the higher elevations, is used for the same crops as the shaly formation, but does not produce as well. Fruit trees, however, are just as thrifty on the sandy as on the gravelly soils.

Kettleville is the principal town of this district and was formerly a lumbering center, but now some farming is being done, especially on the hills west of the town, where oats, potatoes, timothy, clover and corn are growing remarkably well.

TIONESTA TOWNSHIP

Tionesta, the county seat of Forest county, is situated in this township, and is surrounded with a good agricultural soil which produces well. The principal farming is done on the hills, north and east of the town at such places as Dutch Hill or the German or Copps Settlement. The Germans who came into this section more than a half a century ago had, before the discovery of oil, made this a very productive soil and still raise better crops than are raised in most other sections of the county.

Such crops as alfalfa are successfully grown here and usually without a failure in seeding. Not only is this the case, but the nitrogen gathering nodules are on the roots of the alfalfa, showing that the bacterium, so essential to the growth of this crop, has been supplied by the farmers or is found naturally in the soil.

Splendid crops of oats, rye, potatoes, buckwheat, wheat, clover and timothy are raised and the only disadvantage the crops experience is that the oil wells produce larger returns at this time than the soils and for these the soils are in many instances neglected by the farmers. The higher elevations, with loamy soils, which, when dug up, reveal a depth, until the yellow clay is reached, of as much as 12 and more inches, showing that some one has been doing some good farming.

BARNETT TOWNSHIP

Barnett township projects between Millstone township, Elk county and Farmington township, Clarion county and, therefore, has these counties for its eastern and western boundaries. The soils are derived from the various members of the conglomerates with the exception of the southern section along the Clarion River, in the curve at Clarington and at Cooksburg, and east of this place where Troutmans and Colemans runs flow into the river where the Pocono sandstone takes part in the formation of the soil.

The broad flat area between Maple and Millstone creeks has clayey, sandy and sometimes stony soils, formed of the various members of the conglomerates, which was covered with an original forest of hemlock of considerable size, but which since the original forest has been cut away, no forests of any special value have grown either on account of the poverty of the soil or because of the burning over of the land.

Some good farming land occurs at Red Cliff in the northern part of the township. In the western central part of the township east of North Pine Grove is some fairly fertile farming soil, similar to that of Red Cliff, formed of the Clarion group.

The "Big Level" of this and McKean county passes through the northern part of this township.

JENKS TOWNSHIP

Jenks township lies north of Barnett and Millstone townships, Elk county, with the Elk county line for its eastern boundary. The strata from which the soils of this township are derived range from the shales and sandstones above the Clarion coal bed in the Clarion group down through the Olean conglomerate.

The "Big Level," already referred to, passes through this township in a northeastern direction and makes an elevated country of magnificent extent, at one time covered with a forest of hemlock not surpassed anywhere in the State, but now so depleted, by being burned over and over, of forest, forest seeds, roots and vegetable covering for the protection of roots and seed and for the maintenance of moisture and fertility, that only scrubby trees are able to keep up the forest development. At Marienville, in the central part of the township, the soil is formed of some sandy shale strata which likely belongs to the Clarion group. The soils is very similar to the soil in Clarion county formed of this group.

This soil, the more shaly and sandy types, will produce large crops of potatoes, oats, buckwheat and wheat and timothy and the clovers, especially the alsike if limed. Lime should not cost so much here because it should be gotten with a short haul from northern Clarion county where it can be burned very cheaply.

The ferriferous limestone, though less than fifty feet above the Clarion coal seams, does not occur here at its customary horizon; but that some material better than conglomerate enters the formation of the soil is evident from the vegetation. Where these higher strata have been washed away, the members of the conglomerate, many times the Johnson Run sandstone, forms the soils all of which are poor. At Byromtown the same vast extent of rolling country, at one time covered with forests now stripped of it and not reforested but instead burned over and over, continues.

HOWE TOWNSHIP

Howe township lies north of Jenks, occupying the northeastern corner of the county. The soils in this township are formed of the conglomerates, beginning at the horizon of the Kinzua Creek sandstone and the Olean conglomerate. The Divide, already referred to, passes through this township and forms a rolling level country similar to that of Jenks township, except that in this township not any of the strata of the Clarion group remain and, therefore, the soils do not have the benefit of the enrichment afforded by this formation.

At Frost on the southern line of the townships, some farming is being done with apparently fair success; the same is true at Watson farm. At Sheffield Junction there is some little farming, but is not very successful. Land too poor, all conglomerate. All should be reforested and burning over prevented. The same conditions prevail in the southern part of the township to the limits of the Divide where the country becomes hilly.

On the Divide between the waters of the Tionesta and Salmon creeks, in the western part of the township, is some moderately rolling farming land that will produce timothy, hay, oats, rye and on the more gravelly, loamy and sandy soils, potatoes. This Divide extends to the Highlands east of Mayburg, along the Tionesta Creek. Here are some original forests of pine and hemlock, on the higher lands and some white oak, red oak, pin oak, and chestnut on the richer soils, while beech and maple occupy the land along the streams where the original forest has been cut away.

Ballstown, Wellers, and Hastings are all lumbering settlements. As long as lumbering, oil and gas will furnish the returns they now do farming will be neglected in this county.

GREEN TOWNSHIP

Green township lies west of Jenks and south of Kingsley, on the Clarion county line. North of Bowmansville, near the southern boundary, on a small divide between Little Boon and Boon creeks, is a rolling, farming section of some fertility. The "Big Level" passes through the southeastern part of the township, and its soil is similar to that of the township in which it has been referred to.

Along the northern part between Coon and Tionesta creeks, is another Divide with soils similar to those between Little Coon and Coon creeks. At Nebraska, along Tionesta Creek, in the curve of the stream, is some alluvial soil of fair fertility. Some distance from the stream the Pocono sandstone likely entered into the composition of the mineral basis of the soil. The elevation above tide at Nebraska is 1,095 feet, while some of the ridges above the Coon creeks attain a height of 1,775 feet above. This means that there is hilly country throughout the western part of this township.

HARMONY TOWNSHIP

Harmony township occupies the northwestern corner of this county. The Kinzua Creek sandstone and the Olean conglomerate, except along the streams, form the soils of this township. On Kellys Hill, or the country between the Allegheny River and West Hickory Creek, is a fairly fertile farming section with moderately rolling land some even nearly level with clay soils and rather inclined to be wet, while the more rolling formation has loamy, sometimes gravelly soils, well drained and productive. Apple trees look thrifty here and bear well or at least this was the case when this investigation was made.

South of West Hickory, along the Allegheny River, where West Hickory Creek flows into the river, is a considerable acreage of alluvial formation of soils which should be utilized for trucking in so far as posible. Where the land is too wet it would pay to underdrain it. West of the river and West Hickory Creek, on the river hills, is a moderately rolling tableland extending into Venango county, with soils formed of a sandy shale which, where the shale prevails, are loamy and where the sand is in the ascending are more sandy and sometimes stony.

Wheat, rye, timothy, potatoes and clovers, where lime is applied, return very good crops. Apple trees look thrifty and bear well. It seems that this is one of the fruit sections of this county. Alfalfa will thrive equally as well here as on Dutch Hill.

The following analyses gives a composition of a limestone, four miles east of Tionesta, on Tionesta Creek.

2nd Pa. Geo. Survey M 3 page 90.

Carbonate of lime,	40.642%
Carbonate of magnesia,	1.172%
Oxide of alumina and iron,	2.120%
Phosphorus,	0.018%
Siliceous matter,	55.160%
	99.112%

VENANGO COUNTY

Venango county was erected into a county by Act of March 12, 1800, from parts of Allegheny and Lycoming. It contains 423,040 acres, of which 246,367 acres is land in farms, and of which 145,813 acres is improved farm land. 9,200 acres were planted in corn in 1909, yielding 284,567 bushels; 14,515 acres were sown with oats, yielding 386,461 bushels; 4,100 acres were sown with wheat, yielding 65,435 bushels; 8,377 acres were sown with buckwheat, yielding 152,714 bushels; 157 acres were sown with rye, yielding 1,862 bushels; 2,745 acres were planted with potatoes, yielding 304,457 bushels; 41,010 acres were sown with all forage crops yielding 39,297 tons of the various kinds of hay. Of the 145,813 acres of improved farm land, 80,104 were used for raising farm crops while 65,709 were not so used and were likely producing weeds. At this time Venango county had a population of 56,359 to feed, 15,292 cattle, 6,285 horses, 43 mules, 9,937 swine and 11,676 sheep.

Venango, according to the Second Geological Survey of Pennsylvania, has an area of valley bottom drift along the streams, an area of the Crawford shales, which is the most extensive in the county, an area of Sharon conglomerates and Shenango sandstone, an area of conglomerate, an area of the lower productive coal measures and the ferriferous limestone. According to the U. S. Geological Survey, the whole county, with the exception of a few small areas in Richland, Rockland, Scrubgrass, Clinton, Irwin and Cranberry townships, belongs to the Allegheny formation.

The Allegheny River flows into Venango from Forest county, and meanders westward to Franklin, and then southeastward to the corners of Butler and Clarion counties. At Franklin, the county seat, French Creek flows into it from the northwest, then Sandy Creek from the west, and East Sandy from the east, and Big Scrubgrass from the southwest. At Oil City, Oil Creek flows into the Allegheny, and a little further east, Pithole Creek and Stewarts Run flow into it. Sugar Creek flows into French Creek from the north about three miles west of Franklin.

These streams make the drainage of the county. With these numerous streams and their still more numerous tributaries, the county contains a large number of narrow valleys and ravines, with many steep slopes along which the strata already referred to outcrop. The valleys of these streams have been filled with glacial material and the scouring of the glacier to varying depths.

The scouring of these hills and the translation of these scoured materials down the hillsides and into the valleys makes the soils of this county differ from those of many other counties, because the soils of the hilltops, in many places, are so thin and the underlying

material so compacted that they are of little value for farming purposes, while the soils on the hillsides, both on the upper and lower inclines, are fertile and produce large and superior crops, while the soils in the valley bottoms are easily the equals of any soils of this type in this State. These different soils will be referred to in the discussion of the townships.

RICHLAND, ROCKLAND, SCRUBGRASS, CLINTON AND IRWIN TOWNSHIPS

These are similar in formation. In these townships are preserved twenty-six patches of the lower productive coal measures, together with the ferriferous limestone, and in some instances, the overlying Kittanning coal beds. From this it is evident that the scouring of these hills, which has not been at all equal to that of the northern hills in this county, differs from that of the hills in which neither coal, coal or carbonaceous shales or limestone occurs and, therefore, the soils differ in formation and fertility on hills, hillsides and in the valleys.

This is very evident in Richland township, on the hilly formation east of Emlenton and along the road from this town toward Porterfield and into Clarion county, where blue grass and white clovers grow naturally along the highways, and in many places, from this place northward into Rockland and Pinegrove townships. On these sections the hard pan, wherever it was found, was deeper under the surface and did little if any harm to farming and was not as noticeable in the forest growth.

In Scrubgrass township, west of the river at Crawfords Corners, about two miles west of Emlenton, on the road to Clintonville, a little south of this place, the ferriferous limestone occurs and coal shales, together with thin coal veins crop out. These soils show the effects of these formations in more thrifty and vigorous tree growth and the presence of clovers and blue grass, which are lacking on the soils of the scoured uplands of the northern townships.

Along the road to Clintonville at a number of places, in Scrubgrass and Clinton townships, the limestone occurs as well as the limy shales, and on the road to Kinnerdville, in Clinton township, these same formations crop out, and in every instance show their salient effects in tree and crop growth.

Along the Butler and Franklin Pike, (this is said to be a pike), between Harrisville, in Butler county, and Mechanicsville in Venango county, and between these places and Grove City, in Mercer county, occur some of the most fertile soils in these three counties. Along this same pike further north and west, the soils are more level until the French Creek hills are reached, when the land becomes rolling and in some places hilly.

In Clinton township, at Clintonville, and in a number of places in this vicinity, the ferriferous limestone outcrops in the hills where it can be readily quarried and burned into lime, with the coal veins overlying, lime can be made cheap here, under these conditions and it should be made because the soils of the conglomerate formation so extensive in this county are in many instances very deficient in lime.

The same conditions prevail in southern Irwin township. Upon the uplands along the river in northern and central Scrubgrass and northern Clinton townships, are some beautiful rolling sections of fairly fertile soils, largely of drift material, mixed, however, with the ground materials of the underlying strata. A divide between Wolf Creek in Mercer county and Big Scrubgrass Creek in this county, passes through Irwin township and forms some gently rolling country, with soils formed of drift material and some intermixture of underlying rock of good productive capacity. The drift material is composed of clay mixed with bowlders of granite, limestone and sandstone. The clay frequently forms a hard pan which, in some instances, is close to the surface, and where this is the case, the soil not usually productive and the production of paying crops depends largely on the season. If the season is too wet, the crops will be drowned out, and if too dry, they will dry out. In central Sandy Creek, in the vicinity of Springville, are some of these soils, while at the same time some of the best soils of this formation occur here.

In the northeastern part of the township, upon a divide, is a moderately rolling section, with soils especially adapted to raising the hay grasses, such as timothy, and on the more acid soils, red top. In the northwestern part of the township, at Maple Grove, both the Mercer upper and lower limestone occur and have been burned into lime for agricultural purposes.

FRENCH CREEK TOWNSHIP

French Creek township lies north of Sandy Creek township, along the Mercer county line. The Homewood sandstone outcrops along the streams and forms a rough country, of poor, sandy soil in many places. This sandstone is massive in this section, not as it is in a large part of Lawrence county, where it is shaly and forms a fairly fertile soil. The soils are formed largely of drift materials, mixed with clay, which, in some places, forms hard pan, but usually is fairly productive.

From Franklin, the county seat, northwestward along French Creek, the country is hilly and not much farming is done, except on the uplands away from the stream. At Utica the country has become rolling, and large farms evidently exist here. The Mercer upper and lower limestone occur in the western part of this township, but have

not been used for making lime. It seems that this stone could be crushed and ground for use on these soils with the best kind of results.

CANAL TOWNSHIP

Canal township lies north of French Creek township and has French Creek for its southern border, with the northwestern section touching Crawford county. On the ridge between French and Sugar creeks, in the southeastern part of the township, along the ridge road, is a section of rolling upland, ground down by glacial action, underlaid with hard pan and not very productive, but will grow forest trees. The hills along the streams are steep all along this southern section, while the uplands are rolling and easily farmed. In the central and northern nart of the township, the land is moderately rolling, and with careful farming, productive. This is a hay soil and a rotation should be arranged to use these soils for this purpose.

Sugar Creek, Oakland, Jackson, Plum and Cherrytree townships are very similar in formation. In Sugar Creek township, along the Allegheny River, are some of the steep slopes already referred to, and most of these are useless as farming land, except in a few instances, such as occur directly northwest of Franklin on French Creek where these river hills have been converted into pasturing land of considerable value. If this can not be done, these hills and ravines should be kept in forest.

On the road between Franklin and Cooperstown, in Jackson township, occur the formations already referred to—the scoured hilltops, the gravelly upper and the loamy lower hillsides and the valley bottom drift. At Shively's Corner, on this road, in Sugar Creek township, occurs the hard pan, the scrub oak and the stunted or smaller tree growth so characteristic of this special condition. On the slope of the hills of Sugar Creek, below the hard pan, is a magnificent forest of white oak, chestnut oak, black oak, some maple and a few beech, showing that a more congenial soil condition prevails here than on the ridges.

At Cooperstown, in the valley of Sugar Creek, is a characteristic bottom drift formation, with a soil of well nigh inexhaustible fertility. All along Sugar Creek this formation continues, sometimes narrowing to a small area, then widening into a considerable valley.

Beginning in Crawford and extending along and on top of the hills west of Sugar Creek, through Plum, northwestern Jackson, Canal, western French Creek and western Sandycreek townships, except immediately along French Creek, is a glacial scoured hill formation, a sloping gravelly and loamy formation, and valley

formations along Sugar, French and Sandy Lake creeks coming in from Mercer county. Another and more extensive one in Venango county, begins also in Crawford county and extends along Oil Creek through Cherrytree, eastern Oakland, eastern Sugar Creek and western Cranberry townships, south of the Allegheny River. Especially striking are the scoured hills south of the Allegheny because in some places the scoured rocks come well nigh to the surface on top of the hills and the thin soil on top of this hard pan is among the poorest in the county, while on the hillsides, in many instances, only a few rods lower than this formation, oak, chestnut, black oak, maple and beech trees grow to large sizes, and where these soils are well farmed, large crops of hay, grain, especially wheat, oats, buckwheat and rye are raised.

Northern and central Cherrytree down to the town of Cherrytree and southwestward to Dempseytown, the rounded hills, and in many instances, the gently sloping hillsides show the effects of the glacial action already referred to. In the northern parts of Cherrytree and Plum townships the glacial drift must be more than 60 feet in depth. Had it not been for this glacial action, there would be little farming land in this county.

President, Cornplanter, Allegheny and Oilcreek townships, east of Oil Creek, are similar in formation to those already described, except that the scouring of these uplands has not been as deep, so as to remove as much of the soil from off the rock as in the western townships, but some glacial action is manifest, and this, together with the disintegration, that has taken place, formed a fairly good soil as is the case in the townships of Forest county, described under that county.

These highlands are all beautifully rolling lands. Southeast of Dempseytown and Oil City Road, between Dempseytown and Oil City, is a magnificent stretch of gently rolling upland and some of it fairly fertile, but some underlaid with the hard pan of the glacial formation and difficult to keep in productive condition.

It is evident that with such difference in formation, these soils, to get the best results, must be managed differently. A farm on the bottom valley drift and one on the hillsides, having the upper gravelly and the lower loamy soils formation, and one on top of the hills, underlaid with hard pan, are three entirely different propositions and require different cropping.

The likelihood is in fact this is the case, all the farms have the three kinds of soils of such different origin and requiring such different management. Eastern Oilcreek township and the whole of Allegheny are of the rolling upland formation with soils formed of the Kinzua Creek conglomerate and a mixture of shales and sandstone which, especially in the eastern section of Allegheny

township, at such places as Pleasantville, has formed soils of such fertility that alfalfa thrives and produces three cuttings a year of, approximately, three tons of hay.

Canada field peas and oats do well here, so does flint corn. Potatoes yield larger returns in this section than any other crop, especially in the sand loam soils. It seems that a rotation of wheat, clover and potatoes should be a satisfactory one. The trouble with farming in this section is, that the oil wells yield much larger returns, with less labor, than the crops that are raised and, therefore, all the farmers who have oil wells on their farms either become too rich to farm or devote all their time to handling oil pumped from their wells. President and Cornplanter townships lie, the former south of Allegheny and the latter south of Oilcreek and Cherrytree.

Between Oil Creek, which flows well nigh through the central part of Cornplanter township and Pithole Creek on the divide between these two, is one of the moderately rolling upland sections with soils of good fertility, easily farmed and can, with good farming, be made to return paying crops of hay, clovers, potatoes, apples, among the cereals, oats and flint corn and buckwheat. Along the northern line of President township, the moderately rolling formation of Allegheny township continues; but upon approaching the Allegheny River, the county becomes hilly both north and south of this stream.

The southwestern part or President and the northwestern part of Pinegrove townships form a Divide between the streams flowing into Hemlock and East Sandy creeks.

Upon this Divide are some remains of the strata immediately underlying the ferriferous limestone, and these form soil of fair productive capacity. In the western part of Cranberry township, both coal and the ferriferous limestone are in such quantity and of such quality that lime can be burned here. At Salina, in Cranberry township, and from this place eastward, but especially westward, along the road to Cochranton is another of these interior uplands, with soils of good agricultural capacity which should be better farmed than they are now. The soils are formed of a sandy shale and some of shaly sand, the former more sandy than the latter and not as fertile but well adapted for raising corn, the grasses and clovers, especially when limed.

CRAWFORD COUNTY

By an act of the Legislature of the 12th of March, 1800, the county of Crawford was formed. It was named for the unfortunate Colonel William Crawford, who was burned by the Indians, June

11, 1782. It contains 664,320 acres, of which 580,411 acres is land in farms, and of which 375,945 acres is improved farm land. 22,999 acres were planted with corn in 1909, yielding 824,102 bushels; 34,772 acres were sown with oats, yielding 1,099,861 bushels; 10,292 acres with wheat, yielding 172,144 bushels; 15,155 acres with buckwheat, yielding 329,064 bushels; 177 acres with rye, yielding 3,286 bushels; 6,542 acres were planted with potatoes, yielding 708,768 bushels, 123,057 acres were sown with all forage crops, yielding 171,887 tons of the various kinds of hay. Of the 375,945 acres of improved farm land, 212,994 acres are used in raising farm crops, while 162,951 were not so used and were likely producing weeds. At this time Crawford county had a population of 61,565 people to feed, 66,094 cattle, 19,536 horses, 80 mules, 31,813 swine and 29,818 sheep.

Crawford county lies south of Erie county, west of Warren, north of Venango and Mercer, on the Ohio State line. The strata underlying the drift material, according to the Second Geological Survey of Pennsylvania begin with the Portage in the Chemung group and extend through the Catskill sand group, the Pocono sandstone, the Mauch Chunk shale the Sharon coal into the Pottsville conglomerate.

The soils of this county are derived largely from two main sources: from the disintegrated drift material and from the decayed vegetable matter in the land reclaimed from former lakes and swamps. On some of the tops and slopes of preglacial hills, which have not been entirely obliterated or planed down by glacial grinding, the underlying strata take part in the formation of the soil, all of which will be referred to in the discussion of the various townships. Preglacial hills presupposes preglacial valleys. These valleys existed and are filled with glacial materials some to great depth.

The drainage of the county is accomplished by the Shenango River, which drains the Pymatuning Swamp and the southeastern section of the county, and flows south through Mercer county. The northwestern section is drained by Conneaut Creek and several smaller streams flowing north into Erie county. The central and northern central parts are drained by Cussewago and French creeks and their tributaries, while the eastern part of the county is drained by Oil Creek and its tributaries, both of these streams flowing south into Venango county.

As indicated by the U. S. Geological Survey, the southeastern and the greater part of the southern section of the county differ in geological formation, in, that here the several members of the Pottsville conglomerate, remains in the lower hills. The Connoquenessing sandstone, another member, underlies the higher hills while

the Homewood sandstone caps the highest elevations, all of which take part to a certain extent in the formation of the soil.

The discussions of the various townships will be taken up as hitherto in harmony with the underlying rock strata. Beginning with the southeastern corner, eastern Oil Creek, Troy, southern Richmond, Randolph, Wayne, East Fairfield, Mead, central Vernon, Union, Fairfield, Greenwood and East Fallowfield townships belong to the formation above referred to, and have soils in the formation of which the several members of the conglomerate have contributed.

WAYNE TOWNSHIP

Wayne township lies in the southeastern corner of the county, on the Venango county line. It is covered with glacial drift all along the valleys and along the hillsides, and on many of the lower hills the glacial materials provide the mineral basis of the soil.

Sugar Lake lies in the northeastern part of the township and is surrounded with a rolling section of drift materials which reaches the depth of eighty feet, according to the records of oil wells bored within the valley surrounding it. The central part of the township is comparatively high and the surface rough and stony and hilly with soils that wash easily. The Sharon conglomerate, one of the lower members of the Pottsville, enters the formation of the soil of the lower hills and produces a more sandy soil than the glacial formations and therefore a soil that washes more readily.

But not only do the lower members of the conglomerate series enter the formation of the soil, but in the southeastern section the hills rise sufficiently high to include all of the Pottsville series and the lower members of the lower strata of the lower productive coal measures so that both topographically and geologically, this township contains the highest rock strata in the county.

Near Deckerts Postoffice the upper Meadville limestone was quarried quite a number of years ago and used for flux at the Old Liberty Furnace. This section could not be located; but on Grass Run it was easily located. It is about two feet thick and seems if it would answer the purpose of agricultural lime it could be quarried here and put on the market at reasonable rates.

The following analysis gives an idea of its composition:

X 24, Page 88.

Carbonate of lime,	27.60%
Carbonate of magnesia,	1.70%
Carbonate of manganese,	0.31%
Carbonate of iron,	3.62%
Alumina,	4.24%

Silica,	60.43%
Water,	1.74%
	99.65%

It seems that this stone does not contain sufficient lime to justify quarrying and burning it and perhaps it would not burn into lime that would readily slake. The stone should be tested at any rate because the soils throughout this entire section are deficient in lime.

A ridge some distance south of Sugar Lake is said to rise high enough to catch the ferriferous limestone but is covered with such a depth of drift materials that the stone has never been exposed if it does occur.

The elevations above tide in this township range from 1,070 on Sugar Creek and 1,520 the highest elevation reported.

EAST FAIRFIELD TOWNSHIP

East Fairfield township lies west of Wayne and has French Creek for its western boundary. Between French Creek and Little Sugar Creek, flowing southeastward through the northeastern corner of the township, is a divide consisting of a ridge from which the descent down to French Creek is rapid, while toward Sugar Creek the incline is less steep, but sufficiently steep to cause washing of the soils which here, also as elsewhere along the hillsides, are partly formed or mixed with some of the underlying Sharon sandstone, a member of the subconglomerate formation. Along French Creek, further south, the land is rolling, and the soil derived entirely from drift materials upon which oak forests thrive, showing that the soil must be fertile. This is true of the southeastern section at Cochranton and vicinity. Elevations range from 1,100 to 1,500 above tide.

FAIRFIELD TOWNSHIP

This township lies southwest of East Fairfield and west of Wayne on the Mercer county line. A wide terrace runs along Conneaut Lake Creek and French Creek about a hundred feet above the level of the streams, upon which are located the most fertile soils of the township. From the central part of the township southward the rise begins until at the Mercer county line the hills rise sufficiently high to include the Homewood sandstone, the highest member of the conglomerates.

While the greater part of the soil is derived from the glacial drift, still the sandstone of the underlying members as the Connoquenessing, on some of the hillsides near the Mercer county line, take part in forming the soil. Further north the sandstone blocks

are scattered over the fields while higher up a ledge of rock from which they were derived crops out, is the material of which enters the formation of the soil.

GREENWOOD TOWNSHIP

Greenwood township lies west of Fairfield, along the Mercer county line, with Conneaut Lake Creek for its northern boundary. A high Divide extends east and west through the township between Conneaut Lake Creek and branches of French Creek flowing into Mercer county.

The first strata which underlies this high Divide that are met going south, is the Shenango sandstone which, however, does not seem to enter the formation of the soil. But further south the Sharon conglomerate covers the surface with bowlders of pebbly sandstone, which here, together with the drift materials and a shaly formation of strata, underlying form the soil, while some of the summits of this high ridge are covered with the Connoquenessing conglomerate, all of which here enter the structure of the soil.

These hilly formations with the drift and the underlying sandy strata, taking part in the formation of the soils, are the fruit growing sections of the county and should be used for this purpose.

EAST FALLOWFIELD TOWNSHIP

East Fallowfield township lies west of Greenwood, along the Mercer county line. Brook Creek forms its western boundary. This creek rises in an extensive swamp in the northwestern corner of the township and flows slowly southward through a series of small lakes accompanied with swampy soils composed largely of muck.

The eastern section of the township is very similar in formation to southern Greenwood. This section contains, or contained, the largest area of Sharon coal of any township of the county. The accompanying strata of this coal, such as the Sharon upper shales and iron ore and the Sharon lower shales, the Sharon conglomerate, below these and the Connoquenessing above them all occur in this section and along the hillsides, and wherever the outcrop unite with the drift take part in the formation of the soil. This should be one of the apple growing sections of the county. The elevations above tide range from 1,000 to 1,400.

UNION TOWNSHIP

Union township lies west of East Fairfield and north of Fairfield and Greenwood, with French Creek for its eastern and Conneaut Creek for its southern boundary.

The northern part of this township is swampy, especially the northwestern corner which touches the Conneaut Swamp. The land southeastward along the Conneaut Creek is low and in some places swampy. The central part of the township is sufficiently high to reach the Sharon coal bed and, therefore, contains the strata underlying it as well as some above it.

The Meadville upper limestone, named for this locality, also occurs in this township, two feet thick, of the same character as that given in the analysis under the discussion of Wayne township. This is another one of the sections that should establish the orcharding business. The elevations above tide range from 1,055 to 1,435 feet.

MEAD TOWNSHIP

This township lies north of East Fairfield and east of French Creek. Meadville the county seat is located in this township. The rock strata occurring in this township range from the Sharon coal down to the Pocono Catskill formation. The Sharon conglomerate covers the ridge northeast of Meadville, as well as what is known as College Hill, at Allegheny College.

The Meadville upper limestone, named for this locality, also occurs here, in a vein probably a foot thick, while the Meadville lower limestone is exposed in the bed of the stream in a vein two feet thick over which the stream falls. The upper limestone seems quite pure and if the vein were sufficiently thick it could likely be made a paying proposition to mine and grind it or burn it for lime for agricultural purposes.

Through the central part of the township the Divide between French Creek on the west and Little Sugar and the branches of Woodcock creeks on the north and east forms a tableland of moderately rolling land with soils largely formed of glacial materials, but along the hillsides of which the outcropping strata combine in forming the soil. In the northeastern part of the township at the head of Little Sugar Creek is a swamp of some extent the remanent of a one-time valley extending north and south between hills 200 feet high in which are mucky soils of splendid fertility.

French Creek evidently flows on a buried valley approximately 300 feet beneath its surface. In this creek valley are some fertile sections of soil adapted to raising all agricultural crops that will thrive in this climate. On the more elevated areas the soils are underlaid, within four feet of the surface, with an impervious hard pan, alfalfa thrives and produces three cuttings of hay in a normal season. The growing of this crop, in rotation with corn, Canada field peas and oats for dairying should be worked out for this county or for this entire northwestern section. The elevations above tide range from between 1,130 and 1,580 feet.

RANDOLPH TOWNSHIP

Randolph township lies east of Mead. Along the western boundary between Mead and Randolph is another tableland, similar to the one passing through central Mead township, and ranging in height about 200 feet above the valley, as already indicated. Along these hills the outcropping strata enter the formation of the soil which, where the limy strata occur, is more fertile than the soil exclusively formed of glacial materials.

On the Divide between Sugar and Woodcock creeks, at Guy's Mills and extending north and south from this place through the township, is a glacier filled valley with soils composed of muck and glacial materials and exclusively glacial; some of them very productive, especially where the ascent to the hill begins.

The ridges, already referred to, one on the western boundary and the other occupying the whole of the eastern part of the township, should be devoted to a certain extent to apple growing, and the raising of grains, while the valley should be given up to the dairy-industry and raising hay. A considerable acreage of this section is swampy and must the underdrained before it can be profitably farmed.

The land in the eastern section of the township, beginning at Black Ash and thence northward, is rolling, with some deep valleys and rough hillsides which should be reforested, while the less steep but smooth hillsides should be farmed better than they now are.

TROY TOWNSHIP

This township lies east of Randolph on the Venango county line. The western section of this township is covered by the ridge formed between the valleys of the Sugar Creeks. This ridge is the same referred to in the discussion of Randolph township. At Troy Center is one of the valleys, with gentle slopes so general through all this section.

In the southern part of the township the drift is said to be 130 feet deep. From Troy Center eastward there is a general rise of the surface until an elevation of 1,600 feet above tide is reached, which rises above the horizon of the Sharon conglomerate, but does not reveal any Sharon coal strata. This eastern section of the township is hilly and the soil not fertile. Well nigh all of it should be reforested.

OIL CREEK TOWNSHIP

Oil Creek township occupies the southeastern corner of Crawford county. Oil Creek flows through the southern section by Titusville into Warren county. This city is built on Oil Creek flats, a gently rolling country, some of it too low for successful farming. Some distance south of Titusville the country becomes more hilly and more

difficult to farm, while northwestward of this city the country is rolling. West of Hydetown the sandy strata form steep hills along the sides of some, of which these sandy strata combine with the glacial drift in the formation of the soil, which influences the fertility not for the better.

The following townships in the northeastern corner of the county: Rome, Sparta, Bloomfield, Athens, Steuben, and Richmond are very similar in strata underlying the drift materials.

ROME TOWNSHIP

Rome township lies north of Oil Creek township, on the Warren county line. Lowlands extending in all directions along the streams well nigh cover the township. These streams flow on deeply drift filled ancient valley, the soil in many places being underlaid close to the surface with hard pan. The eastern section of the township is a swampy region with poor soils of little agricultural value in their present condition.

STEUBEN TOWNSHIP

This township lies west of Oil Creek and Rome and north of Troy townships. The western part of the township makes a low divide, from which the water flows north through Muddy Creek and south into the eastern branch of Sugar Creek, both upon deeply filled valleys, bordered by hills two hundred feet higher, but rounded so that these hills do not appear of such a height.

In the central and eastern sections the soils are similarly formed with both the glacial drift and muck types. Oil Creek flows through the eastern part of the township on a wide valley of drift materials which, in many places, forms soils that will, with good farming, produce all agricultural crops that will thrive in this climate. The elevations above tide range from 1,260 to 1,625 feet.

ATHENS TOWNSHIP

Athens township lies north of Steuben and west of Rome. This township lies entirely below the Pottsville formation, and whatever outcropping strata may occur, differ from those already referred to in the higher elevations of the townships previously discussed. The surface of this township changes in altitude from 1,200 feet along Muddy Creek to 1,600 feet above tide in the central and northern part, thus furnishing ample facility for drainage which is not the case in all these northwestern townships.

The valley along Muddy Creek is wide and filled to unknown depth with drift. In the eastern part of the township the country

is rolling, with outcrops of the Shenango sandstone and sandy shales as well as the Meadville lower limestone at the northeastern corner of the township.

RICHMOND TOWNSHIP

Richmond township lies west of Athens and Steuben and north of Randolph. The same ridge of hills which begins north of Sugar Lake in Wayne township extends through Randolph, enters Richmond and forms a high dividing ridge from the southeastern to the northwestern corner, covered with massive strata of the conglomerate formation which, in many places, enter into the mineral composition of the soil and show their effects, the sandstone producing a more sandy and the shaly a more clayey soil. This ridge is likely the northern limit of the conglomerate formation of any size in this county.

Here again are soils which it seems would be adapted for raising apples. The lowlands are similar to those of the townships already discussed. The elevations above tide range from 1,200 to 1,580 feet.

SPARTA TOWNSHIP

Sparta township occupies the northeastern corner of this county. It contains the highest land in Crawford county rising, many of the summits, 1,800 and more feet above tide. It is covered with drift to a great depth and its soils are formed of this and muck materials wherever swamps and earlier lake bottoms occur.

The East Branch of Oil Creek rises in this township, in Mill Pond, and flows south and southwestward. The land is rolling and some of it of fair quality.

BLOOMFIELD TOWNSHIP

This township lies west of Sparta on the Erie county line. Canadohta Lake lies approximately in the center of this township and is surrounded by undulating drift remanents. The lake is two miles long and three fourths of a mile wide. It is 1,389 feet above tide, the highest lake in Crawford county.

The hills to the west of the lake rise to a height of 1,600 feet above tide, while those along the northern county line rise to 1,700 feet. The land is undulating, most of it easily farmed, with soil of good productive capacity, adapted, the more gravelly and elevated, to raising potatoes, while the more level are especially adapted for grasses. Truck crops should be made a specialty here to furnish vegetables for the summer hotels in this section.

The following townships are underlaid with and have some outcroppings of similar formations: Rockdale, Cambridge, Venango, Woodcock, Hayfield, Cussewago, Spring, Summer Hill and Beaver townships.

ROCKDALE TOWNSHIP

Rockdale township lies west of Bloomfield. The hills already referred to in Bloomfield as rising to 1,600 feet above tide, cover the eastern part of Rockdale and form the divide between French and Oil creeks. These higher lands are moderately rolling and easily farmed, while the land along Muddy Creek, beginning with the southeastern section, is so level that the flow of the creek is scarcely perceptible.

The highland running through the central part of Richmond township touches the southwestern corner of Rockdale, the northeastern corner of Woodcock and the southeastern corner of Cambridge and forms a divide here between small streams flowing toward the four points of the compass.

The elevations above tide in the three townships is approximately 1,450 feet. In both Rockdale and Cambridge, it slopes down toward French Creek which flows westward through both townships to Cambridge Springs where it changes its course southwestward. This section is a gently rolling country of fertile soils adapted for raising the grasses. Large crops of ensilage corn are being raised here during average seasons, and very frequently this corn is allowed to ripen and fair crops are obtained.

North of French Creek, in the northern part of Rockdale and the northwestern part of Cambridge, the country is a very gently rolling plain. Some of the land is too wet and low to farm, but splendidly adapted for grasses. Cambridge Springs, a great summer resort, is located in this township, and some of these soils are used for trucking for which large sections are admirably adapted.

VENANGO TOWNSHIP

Venango township lies west of French and Conneaut creeks which form the boundary between it and Cambridge township. From these streams westward the surface of the country rises from 1,120 feet above tide to 1,400 feet above at the western border, having both the glacial drift and the mucky soils.

The outcropping rock strata in these townships do not rise above the Sharpville sandstone and, in many instances, the Orangeville shales are the highest strata. Wherever the shales enter the formation of the soils, they are usually better than where the sandstone takes part in the formation. The latter are usually dryer and do not need draining.

About a mile west of the town of Venango, in Venango township, the Cussewago limestone crops out in connection with the Corry sandstone. The seam is about two feet thick and the stone contains a sufficiently high percentage of lime to be burned satisfactorily, which, however, does not seem to be necessary, because in the glacial soils, ground limestone serves the lime purposes as well as the burned lime, and therefore this stone needs only grinding. Whether the vein is of sufficient size to justify the establishment of a plant is not known.

The Divide in the northeastern corner of Woodcock township has been referred to. The swampy section in the southeastern corner has been referred to in the discussion of Mead township.

The whole township is moderately rolling, with soils formed largely of glacial drift, with an occasional intermixture of the underlying sandstone. In the vicinity of Saegerstown, a considerable acreage of this land is used for trucking to supply the summer hotels of this vicinity with vegetables. West of Saegerstown in Hayfield township the land rises gradually toward the Divide between French and Cussewago creeks. This higher land, for such it is, is moderately rolling, extending northward through Cussewago township and westward, as already indicated, to Cussewago Creek where the hillsides are quite abrupt down to the creek which, like all the larger streams of the county, flows upon a drift filler ancient channel with so little fall that about the entire filled-in surface is a swamp which needs extensive draining.

The highlands between the creeks, already referred to, attain an elevation of 1,500 feet above tide in the central part of Cussewago township. The same sluggishness of the southern section of the Cussewago Creek continues in this township.

A little west of Hayfield in Summerhill township, is the Divide between Cussewago and Conneaut creeks and Conneaut Lake, and attains a height of 1,320 feet, while at the level of Conneaut Creek the elevation is 990 feet. This highland extends through the middle of Spring township, with an approximate elevation of 1,250 feet above tide, while at Spring Village, along Conneaut Creek, the elevation is only 875 feet, a difference of 355 feet, a considerable amount for this section.

In these higher lands the Corry sandstone outcrops, but has little or no influence in the formation of the soil. This land is rolling and fairly fertile while along the creek it is low, mucky and needs drainage.

BEAVER TOWNSHIP

Beaver township occupies the northwestern corner of the county. It contains, geologically, the lowest strata in the county; but these do not enter the formation of the soil.

Conneaut, Pine, north Fallowfield, Sadsbury and Summit are the swamp townships of Crawford county.

CONNEAUT TOWNSHIP

Conneaut township lies south of Beaver, on the Ohio State line. The Great Divide, which is well nigh entirely confined to Erie county, here runs along the northern boundary line of this township and forms the highest land in the township from which the streams flow north, south and east.

The township is very level because all the hills have been planed down by glacial action and the valleys filled with this and material brought from other sources.

A few rock strata are exposed along the northern line at Summit and in the southern part of the township, in all of which places these sandstone strata help to form the soil and make it a little more sandy. Many sections of the township are swampy and can not be farmed. But the higher lands are among the most fertile in the county. As already indicated, along the eastern line of the township, is a low divide from which the streams flow eastward into Summerhill and Summit townships.

SUMMIT TOWNSHIP

Summit township lies west of Conneaut and Pine and is especially known for its marl deposits near Harmonsburg in the eastern part of the township. These marl beds were likely at one time a part of Conneaut Lake. The marl deposit is formed of the cast off shells of small fresh water univalvues.

The following analyses will give an idea of the composition of unburned and thoroughly burned marl:

	Unburned	Burned
Magnesia,	0.839	1.943
Iron bisulphide,	0.429	0.000
Oxide of iron,	0.170	1.176
Alumina,	0.020	1.119
Potash and soda,	0.116	0.445
Sulphuric acid,	0.222	1.162
Phosphoric acid,	0.023	0.058
Lime,	49.129	82.679
Carbonic acid,	39.356	0.000
Organic matter,	6.512	0.000
Silica,	1.050	10.978
Water,	2.190	0.000
	100.056	99.560

According to the analyses, the unburned marl contains 87.696% of carbonate of lime, which burns into 82.679% of caustic lime. It seems that if this marl would be finely ground and applied to the soil as ground limestone, it would, in these glacial soils, do as well as the burned caustic lime and the cost would be much less.

It has been reported that this same kind of marl exists in Conneaut Lake Creek marsh, which extends from Conneaut Lake, in Sadsbury township to Geneva, in Greenwood township, or probably further southeast. It would certainly pay to investigate this matter thoroughly.

A bed of peat 3 to 4 feet thick lies on the marl in Summit township, which was formerly used to assist in burning the marl, but which, if the marl is ground, it seems should be used in connection either with the ground limestone or the burned lime if it is desirable to burn it to furnish organic matter in which some of the more sandy and gravelly as well as clay soils in this section as well as in the remaining districts are very deficient.

The greater part of Conneaut Lake lies in Sadsbury township immediately south of Summit. This township occupies the country between Conneaut Lake and Pymatuning Swamp, the former located in the northeastern and eastern part of the township, and the latter in the western and southwestern part.

The Pymatuning Swamp extends from near Hartstown, in West Fallowfield township, along the Shenango River northwestward, to the Ohio State line and covers approximately 9,000 acres, in which is included two-thirds of Pine township, lying west of Sadsbury and Summit and south of Conneaut township. The swamp is the remanent of a large lake which, at one time, existed in the southwest corner of the county.

A ridge of some elevation forming a Divide between Conneaut Lake and Pymatuning Swamp extends from East Fallowfield township, through Sadsbury into Summit, on which is some of the best farming soil in this county. The underlying rock strata, such as the Orangeville shale, remain in the soil in many places and take part in its formation.

NORTH SHENANGO TOWNSHIP

North Shenango township lies west of Sadsbury and south of Pine on the Ohio State line. It is covered with drift materials and has well nigh a uniform elevation above tide ranging from 980 feet to 1,170.

South Shenango lies south of North Shenango, on the Mercer county line. The southern part of this township contains the Sharon formations, below which outcrop the Shenango sandstone, the Upper and Lower Meadville limestone strata, too thin and likely too impure to be useful for agricultural purposes. Some of these strata

have entered the formation of the soil in this section. The land is moderately rolling and some of it fertile. Northward and northwestward the township is very similar to North Shenango along its eastern border. Between it and West Fallowfield is an elevated section which contains the Meadville upper and lower limestone, the upper, 1,215 feet above tide at Adamsville in West Fallowfeld township. Along this entire elevation the underlying strata take part in the formation of the soil as is the case west of Hartstown.

Here three and more tons of hay have been raised per acre and there are thousands of acres of equally as good land that are growing little or nothing which, if well farmed, will produce as large and larger crops.

The State Water Supply Commission recently recommended the construction of a 27 foot earthen embankment across the Shenango River three miles north of the Mercer county line for converting the Pymatuning Swamp into a reservoir of water for the use of the cities to the south of it. It is said that such an embankment would increase the water covered area to 15,800 acres.

On the better soils of the rolling formations, oak timber thrives, especially white oak, wherever the soil is sufficiently rich and where the hard pan is not too prominent. The superior chestnut, referred to in Mercer county, while not growing to as large a size in these northern sections as it does in Mercer county and the southern sections of this county, it exists and should be propagated. In the poorer soil the beech, the birch, the maple, and sometimes the pine and hemlock thrive.

Agriculturally, this is among the richest counties in this section of the State, as it exists at the present time, but with a system of underdrainage, with mains built by the State extending from this into Mercer, parts of Lawrence and Butler and Venango counties, with a certain charge for entrance, with small payments to re-imburse the State for the money expended, this county could be made to produce twice or probably three times as much as it now produces.

MERCER COUNTY

Mercer is on the line dividing Pennsylvania from Ohio and was formed by Act of the Assembly, March 12, 1800. It contains 448,000 acres, of which 389,208 acres is land in farms, and of which 272,169 acres is improved farm land. 23,170 acres were planted with corn in 1909, yielding 764,578 bushels; 26,972 acres were sown with oats, yielding 723,205 bushels; 18,965 acres were sown with wheat, yielding 318,965 bushels; 7,073 acres were sown with buckwheat,

yielding 114,907 bushels; 486 acres were sown with rye, yielding 6,386 bushels; 5,543 acres were planted with potatoes, yielding 533, 975 bushels; 73,318 acres were sown with all forage crops, yielding 91,584 tons of the various kinds of hay. Of the 272,169 acres of improved farm land, 155,527 were used for raising farm crops, while 116,642 were not so used and were producing weeds. At this time Mercer county had a population of 77,699 to feed, 35,710 cattle, 14,054 horses, 177 mules, 24,556 swine and 37,705 sheep.

SOIL FORMATION

This county, geologically, according to the Second Geological Survey of Pennsylvania, contains the Crawford shale, Shenango sandstone, Sharon, Olean, Garland and conglomerates. And according to the U. S. Survey, it is, with the exception of a few small sections near Mercer and Stoneboro, entirely in the limits of the Pottsville formation.

The Shenango River flows south through the western part of the county making a great curve eastward into Delaware township, and another westward until below Sharon, it reaches the Ohio State line, within a quarter of a mile and drains the whole western section of the county. The little Neshannock flows south from Jefferson township into Lawrence county draining this section. Otter Creek, flowing south from Fredonia township, joins little Mill Creek at Mercer and forms the Neshannock Creek, draining the central section of the county, and Wolf Creek, flowing south from Stoneboro, drains the southeastern section, while Sandy Creek drains the northeastern section. The highest rocks in Mercer county, geologically, are the lower productive coal measure, which occupy the highlands in the southeastern townships, while the conglomerates occupy the uplands in the central part of the county and the subconglomerates are exposed only along the principal streams. Geologically, Liberty, Pine, Wolf Creek, Findley, Springfield, Jackson, north Lake and Sandy Lake townships are similar. In these townships the Marion coal beds and the ferriferous limestone of Lawrence county have not been completely disintegrated, the effects of which are readily seen throughout this region as well as the adjacent regions of East Lackawannock and Lackawannock and Wilmington townships. The glacial drift has covered these townships as it has all the townships of Mercer county, but the salient influences of the limestone and the limy shales of the coal formation are in evidence throughout this entire section.

Four hill tops in Jackson township, southeast of Jackson center retain the limestone and another hilltop at Henderson, in Worth township. This limestone formation is twelve to fifteen feet thick

along Wolf Creek. At the quarries in Jackson township, it is from nine to twelve feet thick, a sufficient quantity for all agricultural purposes, for this county, for a long period. As already stated, the soils of this section are benefitted by the presence of this limestone and the limy shales of the coal formation to such an extent that with only deep plowing and good cultivation, the clovers thrive very well, so does blue grass. Oak trees of tremendous size, remanents of an original oak forest, that was not surpassed in any other section of the State, still stands.

Many swampy places are scattered throughout Liberty, especially northeastern Liberty, eastern and southern Springfield, and other sections of these townships. Otherwise, the soils are gently rolling, composed of glacial gravel, sand and silt and form the Volusia series of the U. S. soil survey and are of superior fertility.

Mill Creek, French Creek, New Vernon, Pine, Sandy Creek, Otter Creek, Salem, Hempfield, Sugar Creek, West Salem, Greene, Pymatuning, Delaware, Hickory, Jefferson and Shenango are all similar in formation, and with the exception of Borelands Knob, in New Vernon township, and a high knob on the border of French Creek township, do not contain the ferriferous limestone, and are not as fertile as the soils of the previously discussed townships.

All these townships are covered with the glacial drift, even the summit of the highest ridges, such as Keel Ridge, in Hickory township, 1,250 feet above tide. Boulders of all sizes, of granite, gneiss, greenstone, limestone, sandstone, shales, with a bluish white color abound over all the county. Therefore, it is evident that with the exception of those parts where the glacier has left so shallow a deposit of glacial materials, that in the formation of the soil, the underlying rock has been disintegrated. The soils are similar, But there is this exception and it is so evident in its effect that reference should be made to it. At Hope Mills, along the Neshannock, in Springfield township, the conglomerate and sandstone come up close enough to the surface to produce a partial sandy soil. The same thing occurs north and west of the town of Sandy Lake, in Sandy Lake township, in the vicinity of New Lebanon, in Mill Creek township, at Milledgeville, in French Creek township, and in well nigh all the northern, western, southwestern and central townships, as for instance: On the hills west of Greenville and east and west of Transfer, in the vicinity of Clarksville, Sharpsville, and on the hills east of Sharon, on the State road between Sharon and Mercer, and many other places, and at Home's Run, in Springfield township, where is a waterfall of about 60 feet over these rocks. These formations are usually the high lands above the streams and are some

times in forest; but usually they are farmed and so are the gently sloping hillsides, in the formation of the soil of which these sandy shales have shared and have had a beneficial effect.

From this it seems that the glacial scouring of these sand formations has not been injurious as is the case in Venango county. On the hills where this sandy formation occurs, native apple trees, grown along fences and sometimes in irregularly farmed fields, evidently one of nature's apple orchards like those of Wayne and Susquehanna counties. Beside these sections in which the underlying rock has taken part in the formation of the soils, there are, as already intimated, vast acreages of lowlands that will not produce farm crops unless underdrained, which, in some places, is well nigh impossible as is the case in Springfield township, in which are swamps that have no visible outlet and their beds are lower than the surrounding country and, therefore, cannot be drained unless a drainage system of county wide extent be adopted, which would, in many places, be the thing to do and would be a paying investment for the county and the State.

Many of these lowlands were never plowed up after the timber was removed. As soon as the sunlight reached these lowland soils, especially where the limestone and the shaly or limy coal formatiions existed and which the glacier scoured down and formed these lowlands, there blue grass took possession of the soils and formed a pasture not excelled anywhere in the State. Many of these blue grass pastures still exist, and wherever they have been pastured carefully and not over pastured or not pastured sufficiently and the weeds have been kept down, they furnish as good pasture now as at any time, and will continue doing so. Usually the farms are divided so that they contain some of the low pasture lands, some of the more elevated farming lands, and in the sections of the county where the sandy and shaly hill formations occur, also sandy hill formations.

With farms divided in this way, an agriculture should be adopted to take advantage of and make the best of these conditions by producing crops for which the soils are adapted. A farm of one hundred, one hundred and fifty, or two hundred acres, about half of which is pasture land and the other half farming land, it seems that on such a farm, a system of crops should be devised, for the farming land to produce a sufficient quantity of roughage and grain to finish a number of cattle (during the winter) such as the pasture will support during a normal summer or raise sufficient food, both roughage and grain to feed a dairy herd of a size such as the blue grass pasture will support during the summer or similarly sheep or horses.

Farms cropped are managed in this way have and still do exist in this county and bring their owners a return of from $2,000 to $2,500 annually during normal seasons. Such returns can be realized by combining the raising of horses, cattle and sheep and the land improved all the time.

With a rotation of grass, corn and oats, or better, Canada field peas and oats or other methods equally as good, such a thing can be accomplished. With a farm that has some of the sandy upland, apple growing could be made a business and apples and sheep and hogs partly pastured in the orchards and partly on the pasture with some farming on the somewhat elevated farming lands to raise crops to finish the hogs or winter the sheep, could be made a successful farming operation without the employment of much labor. For a more detailed description of the formation of the various soils of the county, which are so similar to those of Crawford to the north and Lawrence to the south, the reader is referred to these two counties, and also to Erie county.

CLEARFIELD COUNTY

Clearfield county was brought into existence by an Act of the General Assembly of Pennsylvania, passed the 20th day of March, 1804, and was formed out of the counties of Huntingdon and Lycoming. It contains 730,880 acres, of which 271,094 acres is land in farms, and of which 161,218 acres is improved farm land. 11,592 acres were planted in corn in 1909, yielding 389,915 bushels; 16,215 acres were sown with oats, yielding 337,640 bushels; 3,861 acres with wheat, yielding 57,984 bushels; 10,529 acres with buckwheat, yielding 168,450 bushels; 6,229 acres with rye, yielding 73,366 bushels; 4,496 acres were planted with potatoes, yielding 447,040 bushels; 1 acre with tobacco, yielding 90 pounds; 39,951 acres were sown with all forage crops, yielding 43,561 tons of various kinds of hay. Of the 161,218 acres of improved farm land, 88,874 were used for raising farm crops, while 72,344 were not so used and were likely producing weeds. At this time Clearfield county had a population of 93,768 people to feed, 16,882 cattle, 5,816 horses, 235 mules, 9,923 swine and 4,532 sheep.

This county lies south of Elk and Cameron, east of Jefferson and Indiana and north of Cambria. The outcropping rock strata from which the soils of the county are derived, begin with the lower barren coal measures, which form the basis of the soil of the highest land, geologically, in the three coal basins crossing the county in

a northeastern and southwestern course. Below the lower barrens come the lower productive coal measures, which form the basis of approximately two-thirds of the soil area of the county.

Beneath the lower productive strata, the conglomerate form, the soil. These outcrop along the Susquehanna River and its tributaries and also make the soil of the Barren Highlands, extending from Packeville beyond the limits of this county into Elk, Cameron and Clinton counties. The Mauch Chunk red shale and the Pocono outcrop, but they do not enter the formation of the soil.

The soils of this county, therefore, can be divided according to their derivation, beginning with the lower barren coal measure soils, the lower coal measure soils and the Pottsville conglomerate soils. The discussion will follow largely along these lines.

The county is drained by the West Branch of the Susquehanna River and its tributaries except the northwestern corner, which is drained by Sandy Creek, into the Allegheny River. The Susquehanna River enters the county in the extreme southwestern corner at Cherrytree and flows in a tortuous northeastern course through the county, leaving it at the extreme northeastern corner. The principal tributaries of the West Branch, in Clearfield, flowing northward are Chest Creek, coming in from Cambria county and flowing through Chest and Bell townships into the Susquehanna, and Clearfield Creek, which also rises in Cambria county, and flows through Beccaria, Woodward, Knox and Bogg's townships into the Susquehanna, near Clearfield. The Moshannon Creek forms the eastern boundary of the county and flows into the Susquehanna River in the northeastern corner of Morris township. Andersons Creek and a host of smaller streams flow into the river and drain the county from the north.

The elevations above tide vary between 870 feet and 2,200 feet on top of the highest knobs, a variation of 1,330 feet.

Gulich, Beccaria, Woodward, Decatur and Morris townships lie in the first basin and have soils derived from the lower barren, the lower productive, with a few small sections of conglomerate strata.

GULICH TOWNSHIP

Gulich township occupies the southeastern corner of the county and lies within the limits of the tableland, referred to in Cambria county, and is the largest and most fertile of this formation in the State. This statement is not as true here as further south, in Cambria county. In the southeastern corner of this township the lower productive coal strata form the soil along Moshannon Creek, and for some distance west of this stream, and as usual, the soil is fairly fertile.

Throughout the central and western part of the township, the lower barren strata undelie the soil and, as usual, it is thin, deficient in lime and organic matter, some of it wet and naturally cold and remains in this conditions until late in the spring, so that it is difficult to get vegetation started early enough for crops to ripen at this elevation. This condition can, to a large extent, be remedied by the introduction of organic matter into these soils and by thorough cultivation. The crops raised are corn, oats, rye, buckwheat, potatoes and hay. These are naturally grass soils and will, with care, grow a splendid sod that will produce large crops of hay.

BECCARIA TOWNSHIP

Beccaria township lies west of Gulich, along the Cambria county line. Along the southern part of the township, at Utahville, the grey shales of the upper barren series form the soil. The land is moderately rolling throughout this southern and southeastern section, with the higher soils stony and gravelly, while the lower are loamy and some times clayey.

On the higher land apple trees look thrifty and bear well. Along Clearfield Creek the land is stony and rough, while along the western border of the township, the Mahoning sandstone occupies the hills. On Clearfield Creek, near Glen Hope, the Lower Freeport limestone has been quarried and lime burned of it. The following analysis shows its composition:

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Carbonate of lime,	93.810%
Magnesia,	1.710%
Sulphur,	0.053%
Phosphorus,	0.008%
Insoluble residue,	2.070%

WOODWARD TOWNSHIP

Woodward township lies north of Gulich. It has a narrower barren section than the townships to the south, while the lower productive coal measures occupy a wider portion of the township to the west and a narrower part on the eastern border. The central section of the barren formation forms the divide between Moshannon and Clearfield creeks. In the southern part of the township, on this Divide, the Mahoning sandstone occupies the surface and forms a poor soil, not adapted to farming. This continues westward beyond Amesville.

This sandstone is not as formidable a rock as it is in Butler county, along Slippery Rock Creek or in Armstrong county, along Mahoning Creek, because in this county its place is frequently oc-

cupied by sandy shales or even slaty strata, but along the higher elevations in the township it retains its original character. Some of the soils of lower productive origin in this township are fertile and make among the richest grass soils in this county.

DECATUR TOWNSHIP

Decatur township lies northwest of Woodward. The trough of the first coal basin traverses the southern and southeastern section and some of the lower strata of the lower barren coal formation remain to form the soil.

The Mahoning sandstone is the lowest stratum of the lower barrens and, therefore, this country should be rough and stony, which, in some instances, is the case, but in others this stone is shaly and has disintegrated and formed a soil which is not as fertile as the soil of the barren shales of some of the higher strata, but is productive.

Apple trees look thrifty here and bear well, and it seems that these soils, with some amendments, would produce fair returns along this line. At Phillipsburg the land is gently rolling, some flat and too low for farming and needs underdraining, which should be done, because these lowlands would make among the best hay soils in the county. The same condition prevails at Boynton and Osceola Mills, as well as further south in Woodward township.

The central part of the township retains the barren strata, while in the western and northwestern sections the lower coal strata prevail. The land is more hilly and more difficult to farm but about equally as productive as the eastern section.

MORRIS TOWNSHIP

This township contains the gently rolling soils of the townships south of it, along Moshannon Creek and the rolling and hilly sections of the townships west and north of it, all having soils of similar structure and fertility so that what is said about the surrounding townships, is true of this township.

Chest, Jordan, Burnside, Ferguson and Knox townships. These five townships are so similar, geologically, that by describing one, an idea can readily be formed of the remainder.

CHEST TOWNSHIP

Chest township lies west of Beccaria, along the Cambria county line. Its outcropping strata are confined to the upper barren coal measures and the lower productive coal series. A high dividing ridge runs through the township between the streams flowing into Chest Creek, on the west and Clearfield Creek, on the east in Beccaria township. This Divide is covered with the shaly strata of the

lower barren coal series, above the Mahoning sandstone. The land on this upland formation is moderately rolling, easily farmed and productive.

This is well nigh a model hay section. On the more fertile soils blue grass grows naturally. Apple trees look very thrifty here and apparently bear well as observed at the time this examination was made. Many of the hillsides along the streams are steep and wash readily, while others are well rounded and rolling and do not wash; the former is the case in the more sandy formations and the latter in the shaly. Southwest of Westover the shaly strata underlie the soil and the land is rolling and fertile, while northeast of this town the hills are steep and sandy and wash easily. In the southeastern corner of the township the Mahoning sandstone cover the highland along the ridge road in many places. Wherever they occur the land is not suited for farming.

Both the Upper and Lower Freeport limestone outcrop along Chest Creek, and from what could be learned of these beds, they could both be utilized for agricultural purposes.

JORDAN TOWNSHIP

Jordan township lies north of Chest and Beccaria, with the same strata forming its soil. A Divide between Big and Little creeks is located in the central part of this township. Along the southeastern section of the township, where the crest of an upper curve in the strata or an anticlinal occurs, the Mahoning sandstone caps the summits of the hills, with, consequently, no farming land while in the vicinity of Ansonville, where a depression in the strata occurs is one of the most fertile sections of the county. Toward the western part of the township the upward curve again appears to such a degree that along the line between this and Ferguson township, the Mahoning sandstone covers the summits and makes soils fit only for forests.

At Ansonville the coal of the lower productive coal measures are mined and both the upper and Lower Freeport limestone strata occur in connection with these coal seams and are said to be sufficiently pure for use for agricultural purposes.

FERGUSON TOWNSHIP

This township lies northwest of Jordan, with soils derived from the lower barren coal measures, the lower productive and the conglomerate, the latter with small sections along the streams.

In the southern part of this township, as already indicated, the Mahoning sandstone occupies the surface on the highlands, while toward the north and northwest, along the streams, the conglomerates outcrop and as usual, make a rough country.

On the uplands in the central and northern section, the land is more rolling and the soils are formed of the strata of the lower productive coal formation which contains limestone limy shales, sandy shales and shaly sandstone easily acted on by the agencies of disintegration which accounts for a rolling formation with deeper, less liable to wash and more fertile soils. These are grass and apple soils. The vicinity of Kerrmoor furnishes a section typical of the above description.

KNOX TOWNSHIP

Knox township lies north of Jordan, with Clearfield Creek for its eastern and Little Clearfield Creek for its northwestern boundary. The outcropping strata are similar to those of Ferguson township. The country is hilly, and some of it difficult to farm, and large acreages not farmed at all.

The crest of the upward curve in the strata, already referred to, in Chest township, passes through the southeastern part of this township and forms a divide between Lost and Potts runs sufficiently high to take in all the lower coal bearing strata and 240 feet of the conglomerate above Clearfield Creek, giving some idea of the exposed sections that occur and take part in the formation of the soil which from this very fact makes necessarily hilly land.

Between Potts Run and Little Clearfield Creek, is another of these divides, but as this is in the trough of the twisted strata of this section, both the barren coal measures and the lower productives form more moderately rolling upland country, very similar to that referred to about Kerrmoor. Similar structures occur at New Millport Olanta and Mitchells Hill, in the northwestern corner of the township. These are good apple soils.

BURNSIDE TOWNSHIP

Burnside township occupies the southwestern corner of the county. The Susquehanna River flows northward through the entire township, close to the Indiana county line.

A high divide extends northward between the river and Chest Creek, which flows within a short distance of the eastern border of the township. In the southern part of the township, on a ridge between Beaver Run and the river, east of Cherrytree, the Mahoning sandstone caps the summit. Still further eastward the same sandstone continues capping the high divide.

Northward on the same ridge the Mahoning sandstone becomes shaly and has disintegrated and formed soils not noted for their fertility, but sufficiently fertile, with good agricultural practice, such as the careful husbanding and applying of all the manure, and

plowing down sods and the use of some lime and such commercial fertilizer as the crops will justify will produce paying crops. East of New Washington the sandstone again caps the hills.

The soils are, therefore, formed of the lower strata of the lower barren series and the lower productives. The lower productive strata form the hillside and the river valley soils. Here on the higher slopes are some fertile sections, adapted to raising all agricultural plants that thrive in these climatic conditions.

Along the river, where Beaver Run and Little Beaver Run flow into it, and such places as Patchinville, Burnside and Dowlers Junction, are good, strong alluvial and deluvial soils well adapted for raising dairy crops, such as silage, corn, Canada field peas and oats, and the hay grasses.

BELL TOWNSHIP

Bell township lies north of Burnside. The strata, which form the basis of the soils, range from above the Mahoning sandstone down into the conglomerate.

In the southern central part of the township where the river changes its northward course to northwestward, and where Chest Creek and a number of smaller streams flow into it, is a moderately rolling section of land, some of it low, all of it formed of the deluvium from the hills and from river alluvium. The same condition prevails at Mahaffey.

Through the northern central part of the township, the crest of the Divide between the water flowing into the Ohio and Susquehanna rivers, passes, reaching a height of 2,200 feet above tide. The Mahoning sandstone occupies the summit of this Divide.

Along the southeastern slopes of the mountain on the lower productive shales is quite an extensive farming section more of which, evidently, was farmed at one time than is done at the present. This is natural grass and apple soil, from appearances, equal to some of the apple soils in Susquehanna and Wyoming counties. Some limy shales occur along the lower slopes of these hills.

During this investigation, good stands of timothy sown in the corn during July were seen at a number of places here and throughout the county. If timothy, hay and corn could be made to follow each other with good results, farming could be made a paying operation here.

GREENWOOD TOWNSHIP

Greenwood township lies east of Bell and north and west of Ferguson. The Susquehanna River flows, approximately, through the central part of the township.

As already indicated in the discussion of Ferguson township, the Mahoning sandstone occupies the highlands in the southeastern section. What is true of this section is true of the highlands of all sections of this township where the barren measures exist.

The elevations above the tide of these barren measures range from 1,600-1,800 feet. Along the river and northward to the township line and beyond, the lower productive coal strata form the soil. In this part of the township are the best farming soils, derived from these lower productive strata. South of the river three limestone veins, the Upper and Lower Freeport and the Johnstown cement bed, occur and from what it was possible to learn during this examination, the Freeport veins are sufficiently pure to make lime for agricultural purposes either as the ground stone or burned lime.

PENN TOWNSHIP

Penn township lies east of Bell and north of Greenwood. The best farming soils are well nigh entirely derived from the lower productive coal series, except some barren strata above the Mahoning sandstone, which covers nearly all the Highlands. The land in the northern and western part of the township comes within the high dividing ridge, already referred to, in the discussion of Bell township, and rises 2,000 feet above tide. From this it is evident that there is some very hilly land in the western part of this township, very similar to Bell township. In the central and eastern part, but more especially in the southern part, the land is more rolling.

At Grampian, in the eastern central part of the township, is one of these more rolling formations, with soils of good productive capacity, especially along the more gentle slopes of the hills. The soils on the more moderate slopes are derived from the more shaly strata of the lower productive coal measures and, therefore, where disintegation has proceeded further and deeper, more fertile, more easily cultivated soils, with greater water holding capacity have been formed. These soils produce splendid sods which will with careful treatment grow large hay crops for a number of years.

The best management indicates that a sod in the regularly farmed districts, for the best results, should not be allowed to become more than three years old.

Apple trees thrive and are equally as productive as in other sections of this county. As much as three tons of hay per acre have been raised on these soils. The Lower Freeport limestone outcrops about two miles southeast of Pennville besides several other places. The coal and the limestone are so close together that the stone can be burned at the quarry.

PIKE TOWNSHIP

This township lies west of Penn and Bloom. The strata range from above the Mahoning sandstone down through the conglomerate in the northern part of the township. In this northern part of the township the highlands, produced by the upward curving of the strata, already referred to in Bell township, bring up the conglomerate formation and it makes the soil on what is known as the "barrens."

Along the southern part of Anderson Creek and in the vicinity of and at Curwensville, are some beautiful farming sections, of fertile soils, adapted to all farm crops that will thrive here. Throughout the southern section of this township the soils are similar to those described in the neighboring townships.

LAWRENCE TOWNSHIP

Lawrence township lies east of Pike, Pine and Houston and extends from the Elk county line to Little Clearfield Creek. The strata from which the soils are derived range from the upper barren coal series down to the base of the Pottsville conglomerate.

The highland between Little Clearfield Creek and the Susquehanna River catch the lower part of the lower barren series, and the soil all along is similar to that described further south along the river. Northwestward from Curwensville, at such places as the Susquehanna Bridge, are some alluvial soils of splendid fertility, especially adapted for trucking or dairying or any type of intensive farming. These soils extend to Clearfield, the county seat, which is located in this township, and eastward along the river, especially in the vicinity where Clearfield Creek flows into the river.

From Clearfield northward through the valley is some moderately rolling land of good fertility. Further northward to the reservoir, the country is rough until the tableland of the State Game Preserve is reached. Here is a magnificent plateau of rolling land of the Pottsville formation, extending from Bloom through Pine, Lawrence, northern Goshen, Girard, Covington and Karthaus townships.

The location of the State Game Reserve in the so-called barren section of this county will, within the next twenty years, prove one of the greatest blessings that this county has enjoyed because forest fires must not be permitted to ever get a start and, therefore, both game and the forest will be preserved. These regions are from 2,100-2,200 feet above tide.

About two miles east of Clearfield the Freeport lower limestone outcrops and has been quarried of which the following analysis shows the composition:

2nd. Pa. Geo. Survey, H 5 Page 133.

Carbonate of lime,	91.888
Carbonate of magnesia,	1.892
Sulphur,	0.135
Phosphorus,	0.031
Insoluble residue,	2.770

BRADFORD TOWNSHIP

Bradford township lies east of Lawrence and north of Boggs. The rock strata, from which the soils are derived, are largely the lower productive coal shales.

In the southern part of the township the land is sufficiently rolling to make farming comparatively easy. This is especially the case at Mineral Spring and southwestward from this place. At Woodland the land in the lower productive measures is moderately rolling and fertile. In many sections along the southern border of this township oak timber thrives, showing that more fertile soils exist than in many parts of the county. At Bigler similar conditions, to those already described in this township further west, exist.

The central part of the township has some highlands of the lower barrens which are not as fertile as in the southern part of the township. A so-called Rock City of Mahoning sandstone occurs south of Half Moon bend in the river in the northern part of the township. In the curves along the river is some good alluvial soil adapted especially for raising the hay grasses and corn for silage. The more sandy types will do well for market gardening.

BOGGS AND GRAHAM TOWNSHIPS

Boggs and Graham townships lies, the former south of Bradford, and the latter, east of it, in the same upward curve of the underlying strata, which has caused the disappearance of so much of the upper barren strata that nearly all the soils are derived from the lower coal bearing series. The conglomerate, by the curving of the strata, has been brought up to such an extent that gorges have been formed through it along Clearfield and Little Clearfield creeks, while between Blue Ball and Wallacetown, on the crest of this upward curve, the conglomerates cover the country and make a rough soil of no value for farming.

On the hills away from the streams and from the crest of the upward curve, or anticlinal, the soil is derived, as already indicated, from, approximately, 200 feet of the lower productive coal strata.

Among these strata the ferriferous limestone is located in the counties to the southwest of Clearfield; but in this county, this stone does not appear and, therefore, the soil formed of these strata is not as fertile as would appear from the location in the strata of

other counties. Northwest of Wallaceton and southeast of Blue Ball are moderately rolling, easily farmed soils, formed of the strata above indicated. Graham township, being located on the same upward curve of the strata, has very similar soil structures.

Brady, northwestern Union, Sandy and Huston townships, lie in the trough of the third coal basin, and their soils are formed of the upper barren and the lower productive coal measures, except the southeastern corner of Union township, which contains the Pottsville conglomerate. Brady and Sandy townships lie along the Jefferson county line and occupy the northwestern corner of the county. The high ridge, already referred to, as passing through northern Bell and northwestern Bloom, passes through southeastern Brady, and is capped with Mahoning sandstone about 2,100 feet above tide.

Beginning in the southeastern corner on the Divide, between the streams flowing into Mahoning and Anderson creeks, is some moderately rolling farming land of good quality. Northwestward from this Divide the high ridge of the southeastern corner and along the southern border of the county, expands into a magnificently moderately rolling farming section, extending northwestward to Boon Mountain, with soils formed of the shaly strata of the lower barren coal measures.

There are some exceptions to so general a statement, because, near Luthersburg, is a hill about 2,000 feet above tide or nearly as high as the ridge along the southern border of the township of which, the Mahoning sandstone, the lowest member of the lower barren strata, capps the summit. In this eastern and southeastern section, therefore, the soils are formed of the lower productives and the lower barrens and are usually more productive.

In the vicinity of Luthersburg is an area of soils derived from the intermingling barren and productive strata, as well as soils formed entirely of productive measures. The soils of both formations are more fertile than the barrens. This same conditions prevails south, southeast and southwest of Luthersburg. The Lower Freeport limestone crops out along the road southeast of this town. It is sufficiently pure to make lime for farming purposes. The vein is three feet thick. In the northern part of this and throughout Sandy township, the soil is entirely formed of the lower barren shales. They are among the best soils of the lower barren series in the State, adapted to raising all the regular farm crops that thrive throughout this section.

From DuBois northeastward to Windburn and to Pennfield, on either side of the Bennett Branch of the Sinnemahoning, these lower barren strata form the soil. In the vicinity of DuBois, the country is beautifully rolling and much of it fertile especially east of the city. The valley of Bennett Branch has some fertile soils

but the hill soils are usually thin. Along the Clearfield and Pennfield road where the lower productive coal strata and the conglomerate unite in forming the soil the land is moderately rolling and from the wood growth it must be fertile.

Apple trees look as thrifty here as anywhere in this or any other county and bear as well.

GOSHEN, GIRARD, COVINGTON AND KARTHAUS TOWNSHIPS

These townships occupy the area north of the Susquehanna River and east of Lawrence township. The farming land of these townships is well nigh confined to their southern sections, except the northern part of Goshen. Along what was at one time the Karthaus Caledonia Pike, the soil is fertile and would evidently produce the grass and apples. Timothy grows in corn after the corn was cut and formed a regular sod.

This section is a Divide between Bennett's Branch and the streams flowing into the Susquehanna River. The southern part of this township has some good farming soil on the coal shales, but the area is small.

Girard has similar conditions except along the river and some of the adjacent sections.

Covington lies west of Girard. This township is not as hilly, and from appearances, has a more fertile soil, derived from the Clarion sandstone (so prevalent in Morris township) and the Kittanning shales. These two formations must be superior as soil formers, or conditions such as exist here would not exist.

Fairly fertile farming land exists in southern Karthaus township and extends across into East Keating township, Clinton county. A farmer in this county who conducts a dairy and partial fruit farm, with no better soils than thousands of acres in other parts of the county, said it would require a salary of $2,500 to $3,000 a year to justify him to take up another proposition.

JEFFERSON COUNTY

Jefferson county was organized from a part of Lycoming county, by an Act, approved March 26, 1804. It contains 426,240 acres, of which 249,189 acres is land in farms, and of which 162,339 acres is improved land. 11,803 acres were planted with corn in 1909, yielding 328,824 bushels; 20,560 acres were sown with oats, yielding 471,143 bushels; 6,369 acres were sown with wheat, yielding 97,532 bushels; 11,129 acres were sown with buckwheat, yielding 198,040

bushels; 3,782 acres were sown with rye, yielding 45,195 bushels; 3,940 acres were planted with potatoes, yielding 397,230 bushels; 37,180 acres were sown with all forage crops, yielding 34,454 tons of the various kinds of hay. Of the 162,339 acres of improved farm land, 94,763 were used in raising farm crops, while 67,576 were not so used and were likely producing weeds. At this time Jefferson county had a population of 63,090 to feed, 13,826 cattle, 6,046 horses, 188 mules, 10,528 swine and 3,069 sheep.

SOIL FORMATION

The outcropping geological strata of rock from which the soils of Jefferson county are derived, begin with the barren coal measures, geologically, the highest, followed by the lower productive coal measures, the Pottsville conglomerate, the Mauch Chunk red shale, and lastly, or the lowest, the Pocono sandstone. The last two are only exposed in the valley of the Clarion River, on the northern border of the county, and on the west central border along Red Bank Creek, and do not enter into the formation of the soil. According to the United States Geological Survey, the southeastern section, with the exception of the extreme corner, is in the Conemaugh formation. Nearly all of the central, northeastern and western sections are in the Allegheny formation, except a section in the north, which belong to the Pottsville conglomerate.

The drainage of the county is all westward into the Allegheny River, first, through the Clarion River and its tributaries along the northern border, second, Red Bank Creek and its tributaries in the centre and third, Mahoning Creek and its tributaries in the southern section.

The elevations above tide vary between 1,131 feet at Pattons and 1,405 feet at Falls Creek, and 2,000 feet in the southeast corner in Gaskill township.

GASKILL TOWNSHIP

Gaskill township occupies the southeast corner of the county. The surface generally throughout the township is high, especially the southeast corner, which has elevations of 2,000 feet above tide. Other sections of the township, such as the ravines of Ugly and Clover runs are rugged because of the outcrop of the Mahoning sandstone. This same sandstone, which is at the base of the barren measures, is in evidence all over Gaskill township, along Ugly Run, Stony Run, Clover Run and into the valley of the Mahoning.

Wherever these rocks come to the surface, the land is invariably such that it is not fitted for agriculture and should be allowed to remain in forest. Sections of elegant farming soils exist in the vicinity of Hudson and in the northwestern corner of the township

on the easily disintegrated shales of the barren strata, and here, at an earlier day, and at this time, to a certain extent, exists a prosperous farming community. This soil will produce all of the agricultural as well as market garden crops that climatic conditions will permit to grow. About a mile east of Ugly Run and close to the Indiana county line, the Freeport upper limestone outcrops. The stone seems of good quality and could be burned into lime or ground finely and applied to the soil as ground limestone.

BELL TOWNSHIP

Bell township, west of Gaskill and Henderson townships, is so similar in formation that it and the northwestern section of Gaskill can be described together because the same lower barren rock well nigh covers both townships. The surface of Bell township is rolling with broad valleys and gradual slopes making agricultural operations easy. The soils are derived from the lower barren measures which are mainly the readily disintegrated shales. Not only do these softer shales factor so largely in the formation of the soils, but a seam of limestone outcrops near the hilltops north of Mahoning Creek and in the eastern as well as the northeastern, higher elevations produces soils of superior fertility.

HENDERSON TOWNSHIP

Henderson township, as already stated, is similar in formation to Bell, the soils being derived from the lower barren rock. Whatever there is of Mahoning sandstone is of a shaly structure. Above the mouth of Windfall Run, on the hills, two veins of limestone outcrop forming the hilltop soil, the salient effects of which can be seen all along the hillsides. On the road eastward from this place another and higher vein of limestone outcrops overlying the former with an interval of shales which forms the hilltops. These limestone veins are said to be of good quality sufficiently pure for agricultural purposes. The following analyses represent their composition:

H 6 2nd. Pa. Geological Survey, Page 73.

Top Stratum

Carbonate of lime,	92.50
Carbonate of magnesia,	2.49
Oxide of iron and alumina,	1.53
Phosphorus,	.02
Insoluble residue,	2.39

Middle Stratum

Carbonate of lime,	77.14
Carbonate of magnesia,	4.69
Oxide of iron and alumina,	3.79
Phosphorus,	.073
Insoluble residue,	11.77

Lower Stratum

Carbonate of lime,	75.35
Carbonate of magnesia,	9.33
Oxide of iron and alumina,	4.23
Phosphorus,	.017
Insoluble residue,	9.78

Going further north on this road, limestone is exposed on other property overlaid with massive sandstone which represents, likely, the middle section of the analyses above given. About a mile north of this exposure, limestone overlies the sandstone and, likely, represents a fourth deposit. This last limestone is quarried in the Paradise settlement of this township, the hills of which settlement contain the limestone of the barren coal measures and form soils of great fertility, hence the name of the place. In the western section of this township, at Cloe, the county is hilly and the soils are shaly from Punxsutawney to this town, but here a beautiful valley opens along Mahoning Creek which begins or opens the formation of the rolling country eastward. On the hills about Punxsutawney, especially those south of the town, the red shales of the barren rocks form the soils, and as is usually the case, the soils are more fertile and make the best kind of soils for cereal grains. These same shales also occur in the Paradise settlement soils.

Porter, Perry, Young, eastern McCalmont, eastern Winslow and southern Ringgold townships have soils derived from the same rock formations. The top being usually a thin covering of the barren measures and the lower productive coal measures forming the hillsides and many of the valleys which here, when the slopes are gentle make the best farming land.

The Divide between Mahoning Creek and Pine Run, in Porter township, is one of these and furnishes a good illustration. One of the main wagon roads of this section runs along the top of this Divide, now being made a State road. In many places in the southern sections of this township, the Mahoning sandstone is found on the surface, and wherever this stone occurs, unless it is shaly, the soils are too rough for farming and not so desirable. But with this lowest of the barren measures on top and below it, the Upper Freeport and the Lower Freeport limestone, even these soils, with all the evils

of the Mahoning, can, by the application of this limestone, be improved. Going east along the Perryville road from the Methodist Church, the hills are strewn with large boulders of this rock making the soils useless for agriculture and, therefore, should remain in forest or be reforested.

The following limestone occurs in this township: The Freeport upper, in one of the two detached knobs on the Travis and McClellan farms; the Travis Knob contains the Freeport upper coal with a covering of loose limy shale, while the McClellan Knob contains the Upper Freeport limestone. The Lower Freeport, as already indicated, the Johnstown cement rock and the ferriferous limestone, these last three are found along the middle branch of Pine Run. Another place where the Upper Freeport limestone occurs in such a way that it can easily be used for making productive the soils of the Mahoning, is on Foundry Run where this limestone vein is 8 feet thick and in sufficient quantity for many generations.

The following analyses gives the composition of the ferriferous limestones:

	Ferriferous
Carbonate of lime,	82.39
Carbonate of magnesia,	1.89
Oxide of iron and alumina,	4.65
Phosphorus,	.30
Insoluble residue,	8.02

PERRY TOWNSHIP

Perry township soils are formed, in several instances, of barren shales, in many places of the Mahoning sand, which, in some localities, is 50 feet thick, coal shales, the Freeport upper limestone and limy shales. Hardly any of the formations beneath these enter into the composition of these soils. In the vicinity of Foundry Run and its tributaries, the Freeport upper limestone is finely exposed in a number of places, in what likely was meant in Report H 6 P. 13 on the Ilert Farm. The limestone is divided into three sections by intervening shales. The report, above referred to, gives the following analyses of the top and middle bench, the bottom not being reported.

Analyses of top and middle bench:

	Top	Middle
Carbonate of lime,	48.57	90.00
Carbonate of magnesia,	23.76	2.86
Oxide of iron and alumina,	7.25	1.28
Phosphorus,	.62	.01
Insoluble residue,	16.66	3.48

This limestone, the Freeport upper, comes to the surface south of Whitesville, along the roadside, and from it the soils are largely formed as is evident from their fertility.

Coming west in the township to Valier, the limestone forms the soils west of the town and on the northeast side, along the road, it outcrops and was quarried here at some times. Along the road further northeast, (this town is partly in Indiana county) of Valier, the Mahoning sandstone again covers the surface and the oak timber largely disappears, and the beech and chestnut and pine take its place. At Horatio is a fertile valley with gently sloping hills facing east, while the west sloping hills are steep and rocky. On top of the hills south of this town, the soil is fertile, because limy shales overlying a small coal vein along a part of the State road now being built from Punxsutawney into Indiana county, make it so. This town is in Young township and represents this section fairly well, as also the remaining southern section of the township. As already stated, the red soil forming shales, occur here, and also the evidence of a limestone formation, remanents of which still exist and are evident in the fertility of the soil. The soils of southern Ringgold township, along Pine Run, which forms its southern boundary are, with little exception, formed of the rocks of the lower coal measures and are, therefore, more fertile than the soils containing some of the barren rocks.

The Freeport upper limestone and the shaly formations beneath it overspread the southeastern section of this township to Caylor Run and about the head of this run, east of Ringgold, the strata of this stone appear at the hilltops, producing magnificent oak forests now, however, well nigh entirely gone.

West of Caylor Run to Eagle Run the hills are high and some are crowned with Mahoning sandstone, and on the Divide separating the two branches of Eagle Run, the east and west branch, these rocks crown the divide, but on the lower levels the Upper Freeport limestone crowns the hills again making rich and productive soils.

McCALMONT TOWNSHIP

McCalmont township in the southeastern section, along Big Run, the main stream of this section of the township, the barren formations prevail and forms the soils on the uplands, while in the valleys, the productive rocks come up but do not take part in the formation of the soils. One redeeming feature, is the shales in this section, and as far northwest as Shamokin Corners are soft and consequently the land is smooth and good farming soils prevails, easily farmed and with good treatment productive and not stony but loamy in structure. Eastern and southern Winslow township has a topography of hill and valley made up of the barren rock chiefly above the

Mahoning sandstone except in the southern edge of the township and the ravines of Trout and Mix runs. The agricultural soils are largely confined to the uplands of these barren shales, such as those south of Reynoldsville, where these uplands soils are derived from the softer shales of this formation and contain a considerable amount of lime similar to the shales on the hills south of Punxsutawney, both of which, when tested, revealed the presence of a considerable percentage of carbonates.

WASHINGTON TOWNSHIP

Washington township, north of Winslow, is located well nigh entirely on the lower coal measure rock, except a small section in the southeastern corner, along Wolf Run, where the country is extremely hilly and little farming seems to be done. The same condition prevails in the western section along Mill Creek. The farming land in this township as over against the sections of the township already discussed, is formed from the strata of the lower coal measure rock which occupy the higher sections of the valley as well as the uplands of the central section of the township, north of Rockdale forming quite an extensive section of farming land of good quality. At Rockdale the Homewood sandstone covers the country with large boulders. A boggy formation, which seems to be saturated with coal oil, exists near this place. The Lower Freeport limestone occurs on the hills along the Rockdale road. It is so close to the surface that it can easily be quarried and burned to lime with the near by coal which outcrops here also. West of Rockdale, some distance along Falls Creek, the ferriferous limestone outcrops. Both these stone make good agricultural lime.

SNYDER TOWNSHIP

Snyder township occupies the northeast corner of Jefferson county. The soils of this township are derived from the disintegration of the rocks from the Mahoning sandstone in the lower barren down to the Pocono, but which latter does not take part in the formation of the soils. The southern section of the township, by Brockwayville, south and west of this place and along the Ridgway road, is the farming land of this township.

The valley or the basin in which Brockwayville is located, though about ten miles wide, is hilly and so varied in formation that the barren rocks are found in the hills east of this town and the Johnstown cement limestone, a formation in the lower coal measures is also located in the hills in the vicinity of this town and so are intervening coal shales and limestone formations. The Freeport upper limestone is five feet thick here and the Freeport lower, is two feet six inches thick, while the lowest limestone in this formation, the

ferriferous, which also crops out, has a thickness of five feet. With soils derived from the disintegration of all these formations about all soil types should be represented which is the case. At Summerville in this same formation is a beautiful valley of lowlands which needs underdraining but even with this, deep plowing and thorough cultivation can be made dryer and made to produce truck as well as all agricultural crops, especially the hay grasses. Going west from this place the ferriferous limestone outcrop in a number of places making elegant hillside soils covered with blue grass and oak timber; soils fitted for all kinds of agricultural crops.

WARSAW AND PINE CREEK TOWNSHIPS

Warsaw and Pine Creek townships have very similar soil formations. Brookville, the county seat, is located in this township, and is surrounded by the Homewood sandstone formation, which is below the ferriferous limestone, so that here this limestone does not occur and the soils have been derived from rocks containing little lime and that evidently not in combination as the carbonate. From Brookville, northeast along the Brockwayville and St. Mary's road, west of Mill Creek, the soil is formed of the Homewood sand until Maysville, in Warsaw township, is reached. From here the formations include the ferriferous limestone, which is exposed here and there along the hills to Petersburg, at Warsaw and thence northward into Polk township and into the sections of Snyder township, such as Sugar Hill where, as is usual in this whole section, the limestone is found on the hilltops or close to these places, and wherever this is the case, a productive soil exists both on top and at the sides of the hills. At Munderf, whether this place is in Polk or Warsaw townships is not known, but here the ferriferous limestone crops out on top of some of the hills and is burned into lime.

At Silver City and vicinity, the Homewood sand prevails and the soils are not so well adapted for farming, but apples seem to do well here, at least what trees are here look thrifty and with care could be made to return profits.

At Richardsville, the conglomerates crop out, but the Homewood sandstone is the prevailing rock, with massive boulders. North and northeast of Richardsville, the ferriferous limestone again appears with a vein of about five feet. This stone must have been quarried here for a long time and used for making agricultural lime.

At Pekin, while the limestone seems to be absent, the soil is comparatively fertile and produces well, with good agricultural practice, but where the soil does not receive careful management, it does not produce.

Coming back to Pinecreek township, north of Brookville, on the Richardsville road, the ferriferous limestone outcrops with an apparent thickness of about five feet, but the stone is impure and will not slake. This stone might be ground and used as ground limestone on the Homewood sand soils so abundant in this township.

Rose, Clover, Beaver, north Ringgold, Oliver, western McCalmont, and Knox townships have soils derived from the same rock strata.

ROSE TOWNSHIP

Rose township soils, from Brookville to Dowlingville, are derived from conglomerates and are, therefore, not adapted to agriculture because, as usual, the entire country is rough and hilly and only adapted to forests.

West of Brookville, evidently just beyond the line between Pine Creek and Rose, on the hills, the ferriferous limestone crops out and makes good soils adapted to agricultural crops on most of the hilltops and hillsides. This stone has been and is being used for lime. This limestone extends along Coder Run to some distance southwest of the mouth of this streams where the vein has been opened, but the country is very hilly and farming operations extremely difficult and not inviting even with the limestone so close at hand to keep up the productive capacity of the soil so far as this element is concerned.

CLOVER TOWNSHIP

Clover township is located west of Rose, on the Clarion county line. It is hilly except some of the uplands, which are rolling and a few of the valleys along the streams which are sufficiently wide for sections of alluvial soils to occur. Red Bank Creek flows through the township from northeast to southwest, with steep hillsides, the summits of which are about three hundred feet above the stream, which are cut deep by a number of tributaries flowing in from the north, while from the south there are fewer tributaries; but the hills are equally high. The ferriferous limestone is said to be easily accessible and of good quality all over the country. It is quarried near the town of Troy, where it is four feet thick and of good quality, making superior agricultural lime. It is again exposed on both sides of Welshes Run, and a number of other places furnishing sufficient lime for all this section.

BEAVER TOWNSHIP

Beaver township is south of Clover, on the Clarion county line. Little Sand Creek forms its southern boundary, while Red Bank Creek flows on its western border. Both these streams flow in deep, sometimes wide but always rugged hillside valleys. The uplands

of these creeks make the farming lands, the soils of which are derived from the rocks of the lower productive coal measures, which here make rough land frequently covered with sandstones boulders, from the Homewood sandstone. The ferriferous limestone covers some small sections here close to the Clarion county line and a few other places. The eastern section of the township is less stony and more easily farmed. Near Worthville, where the Little Sand Creek crosses the township line, and where the ferriferous limestone strata outcrop, is an extensive level formation somewhat similar to the one at Summerville, already referred to, but more extensive, and is produced from the disintegration of the ferriferous limestone.

Knox township is overspread on the uplands with the rocks of the lower coal measures, similar to the ones already described.

Barnett, Heath and Polk townships border on the Clarion River, which forms the boundary line between Jefferson county on the south and Forest on the north.

BARNETT TOWNSHIP

Barnett township is entirely comprised in a narrow strip of highland between the Clarion River and Cathers Run, the soils of which are derived from the Homewood sandstone and are, therefore, rough, rocky and stony and only fit for forest.

HEATH TOWNSHIP

The Pottsville conglomerate strata compose the surface rock and make a rugged and barren surface of little value for farming except where these sandstones are mixed with the shales and where, therefore, a few sections of apple growing soil occur.

POLK TOWNSHIP

Polk township has a similar soil formation, except a narrow strip extending from Shaffers Corners, southwestward into Warsaw township. Here the ferriferous limestone, together with the lower coal measures strata, occur and form the soil which, in many places, is among the most productive in the county. In a number of places along the Richardsville road, the rock outcrops. It is easily quarried and burns well making a strong lime, a most valuable and at the same time, easily obtained, ingredient so essential in these soils. This country needs agricultural development.

CLARION COUNTY

Clarion county was formed by an Act of the Assembly, passed March 11th, 1839, from parts of Armstrong and Venango counties. It contains 384,640 acres, of which 272,745 acres is land in farms, and of which 185,453 acres is improved farm land. 17,603 acres were planted in corn in 1909, yielding 631,028 bushels; 24,680 acres were sown in oats, yielding 669,810 bushels; 14,560 acres with wheat, yielding 225,463 bushels; 8,492 acres with buckwheat, yielding 164,371 bushels; 1,797 acres with rye, yielding 19,553 bushels; 2,065 acres were planted with potatoes, yielding 229,563 bushels; 43,460 acres were sown with all forage crops, yielding 43,561 tons of the various kinds of hay. Of the 185,453 of improved farm land, 110,657 were used for raising crops, while 74,796 were not so used and were likely producing weeds. At this time Clarion county had a population of 36,638 people to feed, 20,948 cattle, 7,586 horses, 117 mules, 15,548 swine and 6,981 sheep.

Clarion county lies south of Forest and Venango and east of Butler and Venango, north of Armstrong and west of Jefferson and Forest counties.

The outcropping rock strata from which the soils of this county are derived, range from the lower barren coal measures, which remain only in small sections in the highlands of the southern townships down through the lower productive series, the Pottsville conglomerate, the Mauch Chunk red shale into the Pocono sandstone—the last two formations come to the surface only along the northwestern course of the Clarion River. According to the U. S. Geological Survey, this county belongs entirely in the Allegheny formation, except the northeastern corner and a narrow strip along the streams which belong into the Pottsville.

The drainage of the county is accomplished in the northern part by the streams flowing north into the Tionesta Creek, and the streams flowing south into the Clarion River which flows through the entire county in a southwestern course into the Allegheny River, and the streams flowing north into the Clarion River and those flowing south into the Red Bank Creek which forms the southern boundary and in the western part by those flowing westward into the Allegheny.

The townships of this county may be divided into three groups:

1. Those in which remanents of the lower barren coal strata remain in the highlands.

2. Those in which the soils are largely derived from the lower productive coal strata.

3. The townships, the soil of which is largely derived from the conglomerates.

In the first class belong from west to east Perry, Toby, Madison, Brady, Porter and Redbank townships.

PERRY TOWNSHIP

Perry township has the Allegheny River for its western and the Clarion for its northern boundary. The strata from which the soils are derived, range from the Freeport coal group, through the Kittanning, and the Clarion into the conglomerate. The Divide between the Allegheny River and the branches of Licking Creek holds the Freeport group of coal and patches of barren strata. The area of each is very limited in this township.

Between Perryville and West Freedom, a formation entirely differing from any other in this township, opens in a broad valley in which flows a sluggish stream differing from streams in this section.

The soil is silty, sandy and gravelly, formed of stream deposits instead of the disintegrated materials of the underlying strata. In the central part of this valley a hill, in which the ferriferous limestone occurs, rises approximately a hundred and fifty feet above the surrounding country. North of this hill is a swampy Divide between two streams, one flowing north of the hill and the other south into the Allegheny. Along the outside of this valley, the sides are steep, while the inside slopes more gently. This valley contains good farming land.

The hills facing the Allegheny and Clarion rivers are steep, especially the lower two hundred feet, which are markedly steeper than the higher slopes, because the higher strata are those of the lower productive coal measures and the lower, the more sandy and harder conglomerates.

Some fertile farming sections are especially adapted to wheat, potatoes, clovers, and the loamy and clayey soils, to raising the hay grasses. Corn thrives here. Apple trees look thrifty and bear well. In the northern part of the township in the curve of the river where the ferriferous limestone forms the soil on top of the hills and along the less steeply inclined slopes are fertile sections. West Freedom and Dutch Hill are localities of good farming sections. The land is more moderately rolling and more easily farmed. Both the Upper Freeport and the ferriferous limestone are accessible in this township.

An analysis of a sample of limestone from near Upper Hillville, in the southern part of the township, gives the composition in this section of the township:

V. V. Page 124

Carbonate of lime,	96.428%
Carbonate of magnesia,	1.202%
Oxide of iron and alumina,	0.867%
Phosphorus,	0.023%
Insoluble residue,	1.110%
	99.630%

TOBY TOWNSHIP

Toby township lies east of Perry and north of Madison. The outcropping strata range from small sections of the Mahoning sandstone at the base of the barren coal measures down to the Homewood sandstone at the base of the productive measures.

The Clarion and Redbank Divide enters the township near the central part of the eastern township line, and extends southwestward to Rimersburg and thence northwestward through the township. The Freeport coal group occupies these highlands, and where only the strata immediately underlying the upper coal vein form the soil, it is more stony and not as fertile; but where the Freeport upper limestone enters the formation as it does near Rimersburg, on a hill, the land is fertile. Several hills in this vicinity show the salient influence of this limestone.

Along this same Divide, northwestward, these same conditions prevail, although the limestone evidently has about completely disintegrated. In the southwestern part of the township, the strata of the lower barren coal series remain in the hilltops and traces of the Mahoning sandstone usually forms a poor soil.

From some distance below the Freeport down through the Kittanning, more shaly formations produce deeper soils of superior structure more easily farmed and more productive. The land is hilly, but not too hilly for a large acreage to be farmed. The Lower Freeport limestone is available and is sufficiently pure to make strong agricultural lime, as the following analysis will show:

V. V. Page 80.

Carbonate of lime,	82.000
Carbonate of magnesia,	6.311
Oxide of iron and alumina,	2.733
Phosphorus,	0.015
Insoluble residue,	7.940

The coal is so close to this limestone that the stone can be burned where it is quarried and lime made at the least possible cost. The ferriferous limestone also occurs in this township in a number of places and is available for agricultural purposes.

MADISON TOWNSHIP

Madison township lies south of Toby, with the Red Bank Creek on the south and the Allegheny River on the west. The outcropping strata extend from a little above the Upper Freeport coal seam down beneath the Homewood sandstone. From this it is evident that the same strata that form the soil in Toby township, enter the formation in this township. Not only is this the case, but the upward and downward curvatures of the strata are nearly the same.

The country is hilly except near the Divide, already referred to, in the vicinity of Rimersburg, and westward and eastward from this place; and also at New Athens where the hills are less steep and the country more rolling.

PORTER TOWNSHIP

This township lies east of Madison and Toby, along the Redbank Creek. The strata range from the shaly formations on top of the upper Freeport coal seam in the highlands down below the Homewood sandstone.

The country along the Red Bank is hilly and difficult to farm, except among the highlands, where the shales and the limestone form the soil. Along the streams in this township as well as those already discussed beech and maple timber thrive, while on the hills and the rolling upland, oak and chestnut prevails. At New Bethlehem is a narrow section of fairly good farming land along the Red Bank.

Northward from New Bethlehem, along Leasure Run, the ferriferous limestone outcrops until Limestone township is reached. All along the uplands above this, as well as other streams, this stone outcrop until the Clarion and Redbank Divide is reached and, therefore, the strata from which the soil is formed are along the horizon of the ferriferous limestone. At Rockville and Frostburg are sections of uplands or rolling land that are easily farmed and productive.

The Homewood sandstone crop out along the streams, but the upland soils are derived largely from the Kittanning and Clarion shales and the limy strata accompanying these. This formation of soils extends to the northwestern part of the township.

REDBANK TOWNSHIP

Redbank township occupies the southeastern corner of the county, with the Jefferson county line for its eastern and the Red Bank Creek for its southern boundaries.

The strata from which the soils of the township are derived, range from the horizon of the Freeport upper coal bed down through the ferriferous limestone; and at the southeastern corner of the county and township down to the Mauch Chunk red shale, but these lower strata nowhere enter the formation of the soil.

This southeastern section, beginning at Maysville, is one of the fertile farming sections of the county. The soil is derived from the underlying strata of the Kittanning and Clarion group which, as already indicated, contain limy shales as well as the Johnstown cement limestone, and the ferriferous limestone. These shales and limestone have here formed a loamy soil, with an area extending from Millville northwestward beyond Shannondale.

The Freeport lower sandstone is the highest stratum along this section, and instead of being a massive sandstone, it is a shale and

forms rounded, moderately sloping hills, with strong fertile soils which have been benefitted by the disintegration of the underlying Freeport lower limestone. Between Pine Run and Town Run the country becomes more hilly and the Freeport strata form the soil, which is evident, from the fact that the Freeport lower limestone occurs along the northern part of the township, and other Freeport strata throughout the district. The soil here is not as fertile as in the eastern section, already described.

Between Town Run and Leasure Run, and where Middle Run, a smaller stream flowing south, between these two, rises in the southern part of the township the country is hilly and farming attended with difficulty. On the upland upon which Middle Run rises, the country is more rolling, and apparently more fertile than between Pine and Town runs.

Soil amendments, manure, lime and commercial fertilizer would work wonders in these soils. The ferriferous limestone outcrops along all the streams in the township and is usually accessible.

LIMESTONE TOWNSHIP

Limestone township lies north of Porter and Redbank, on the Jefferson county line. The strata outcropping in this township range from the Kittanning group down through the Homewood sandstone.

This is one of the fertile townships of the State, with large sections of soils formed by an intermingling of the ferriferous limestone, the Clarion shales on the more gently rolling formations, with the upland formed of the Kittanning group, as already indicated. These combinations make fertile soils. Here intensive farming of the highest order that climatic conditions will permit should be practiced.

This soil produces a splendid hard red wheat. Clovers thrive here without such soil amendments, as commercial fertilizer, providing the soil contains sufficient organic matter and is plowed deep and thoroughly cultivated. Alfalfa yields three crops of hay during a normal season. This crop will thrive in all the Kittanning and Clarion group soils in this township.

CLARION TOWNSHIP

Clarion township lies north of Limestone, with the Jefferson county line for its eastern boundary. Clarion, the county seat of the county, is located in the western part of this township. Mill Creek forms the eastern and northern boundary of the township.

The higher elevations of this township have soils largely derived from the Kittanning group of rock, while the lower slopes have soils formed of the Clarion group, mixed with the sandy strata of the conglomerates. The fertile soils of this township are largely confined to the southern and partly central section, because, here the

ferriferous limestone occurs in its usual position, at the top of the Clarion group, whereas, north of this southern section, it does not occur, according to the best information obtainable.

West of Corsica, in Union township, Jefferson county, the Kittanning group forms the soil, because of the downward curve of the rock strata, known as the Centreville synclinal, passing through Centreville in Limestone township. Along this synclinal the ferriferous limestone also remains in a vein four feet thick, of which the following analysis gives the composition:

2nd. Geo. Survey Pa., V. V., Page 141.

Carbonate of lime,	95.532%
Carbonate of magnesia,	0.930%
Oxide of iron and alumina,	1.050%
Phosphorus,	.070%
Insoluble residue,	1.960%
	99.542%

From this part of the township to Clarion, the hills are sufficiently high to catch the limestone, but it is absent from its place. The soil is, however, still more fertile than where the Clarion sandstone and the sandy strata of the conglomerates form the basis of it, as is the case in many places along this same road.

The section along the road from Corsica to Clarion forms the Divide between branches of Piney Creek and Mill Creek and the Clarion River. Clarion, the county seat, is located along the end of this Divide, surrounded with a beautiful rolling country. Northward from this Divide the land is naturally poorer, because largely formed of the underlying sandstone of the conglomerates.

MONROE TOWNSHIP

Monroe township lies west of Limestone and Clarion, and has the Clarion River for its northern boundary. The Clarion group of rocks form the soil in the northern part of the township, the Kittanning group largely the central and southern parts, with some remanents of the Freeport lower sandstone, in the highest elevations.

The best soils in this township are found where the Clarion group of strata forms the basis of their structure, especially along the horizon of the ferriferous limestone. North of the soils derived from this group, the conglomerates are the basis of the soils and, as usual, are of poor quality. South of the Clarion group, the Kittanning strata and, apparently, only the lower sections of these make the basis of the soil. The Johnstown cement limestone is absent and

clays seem to occupy its place, instead of shales, and these make, in many instances, the poorest kind of soils, which seems to be the case here.

Further south on the summit of the Redbank and Clarion Divide, the Freeport lower sandstone, though here not a sandstone but a soft shaly rock, forms rounded hills and does not compare with the usual condition of the Lower Freeport sandstone. The limestone seams, with the exception of the ferriferous, are absent from this township, therefore some very lean soils occur.

PINEY TOWNSHIP

Piney township lies west of Monroe and north of Toby with the Clarion River as its northern boundary. The strata from which the soils are derived range from Kittanning upper coal through the Clarion down into the conglomerates.

The formation of the soil is very similar to that of Monroe, except that the Lower Freeport sandstone does not occur in this township, and that at Sligo, on Piney Creek, is one of the best farming sections in the county, with soils formed of the strata ranging along the horizon of the ferriferous limestone. This is largely due to the trough or synclinal which passes through this section and the limestone and limy strata of the Clarion group remain along this stream and its uplands and forms the soils. North of this section the limestone also outcrops and enters the formation of the soil. But wherever the limestone is absent and the fire clays, shales and sandstone of this section make the soil the land is poor.

LICKING TOWNSHIP

This township lies west of Piney, north of Toby, east of Perry and Richland. The soils are derived from the strata, ranging from the Kittanning middle coal horizon down into the conglomerates.

The surface of this township is more moderately rolling than any of the townships south of the river. The land is easily farmed, and large sections of it are fertile, especially south of the river, along the valley of Licking Creek, which now flows into the channel, at one time occupied by the Clarion River, but abandoned by it after it had cut through the neck of the loop on which Callensburg is now situated. In the vicinity of this town, the soil is nicely rolling, more fertile than at any locality along the river. These fertile soils continue along Licking Creek, as already indicated, into the curve of the river, northward from Licking Creek. Southward of the river and at a considerable height above it, the ferriferous limestone and the Clarion strata form the soil of a more hilly, but fertile part of this township.

North of the river are some of the alluvial soils, already referred to, south of this stream. In the northern part of the township, along the road to St. Petersburg, is another section of fertile soils formed of the Clarion group.

Townships north of the Clarion River:

RICHLAND TOWNSHIP

Richland township lies north of Perry, along the Allegheny River. the strata, from which the soils of this township are derived, range from the ferriferous limestone down into the conglomerates, along Turkey Run. Foxburg is located along the river and is the terminus of the Big Level that passes through McKean and Forest counties. St. Petersburg is on top of the river hills, and is surrounded with a rolling section of land.

The hillsides from this rolling upland down to the streams and valleys are steep, and the soils along the hills and in the valleys are poor, as is evident from the natural tree growth. On the hills, white oak thrives, while in the valleys, beech, birch, maple and sometimes hemlock prevail.

The ferriferous limestone occurs at St. Petersburg and east of Emlenton and west of Turkey City. In the northeastern part of the township, this stone comes so close to the surface that it can be quarried with little stripping. Wherever this limestone outcrops, which is usually on the uplands, the soil is always fertile. In some places in these northern townships it forms a regular oasis of fertility.

SALEM TOWNSHIP

Salem township lies north of Richland, on the Venango county line. The soil is formed of the shales accompanying the ferriferous limestone, and the Clarion upper and lower coal seams and the conglomerates. The Allegheny and Clarion Divide runs northeast from Mariasville, through the township, forming a broad open flat highland, with some good loamy soils formed of the shales. At Mariasville the ferriferous limestone outcrops. The ferriferous limestone occurs south of Salem, west of Mariasville and in the northwestern corner of the township.

These limestone deposits are accessible and can be made into lime. In a high knob, "Beals mountain," in the northeastern corner of the township, the ferriferous limestone and the Kittanning coal bed remain and are so close together that the limestone can be burned where it is quarried. This knob is 1,600 feet above tide.

BEAVER TOWNSHIP

Beaver township lies east of Richland and Salem and north of Licking. The soil is largely formed of the conglomerates, except at Edinburg, Knox and Beaver City where the ferriferous limestone and

its accompanying strata form the soil and make it productive. Sufficient limestone occurs here to lime the township which, if it were done, would make a large area of land productive.

The land is usually poor and does not produce well enough to make farming attractive except at such isolated places where the disintegration of the ferriferous limestone makes its effects felt. The land is rolling, especially the upland at such places as Jefferson City.

ASHLAND TOWNSHIP

Ashland township lies north of Salem and Beaver on the Venango county line. The Clarion-Allegheny Divide runs through this township. The Clarion group seems to remain intact. In consequence, the soils are more fertile, especially those on the higher elevations, because here the ferriferous limestone occurs and enters the formation of the soil with the effects of producing a soil that possesses many of the good qualities that limestone imparts. In several parts of this township, apples are being raised, which, it seems, if the trees would get the attention they should have could be made a very important industry.

ELK TOWNSHIP

Elk township lies east of Ashland and north and east of Beaver. The soil structure is the same as that of Beaver township, except that there is a larger area of productive soils in the latter township. The soil, formed of the Clarion coal shales, as it largely is, should contain the ferriferous limestone, but with the exception of several small sections, one in the southeastern part and one at Iron City and one at the head of Deer Creek, this limestone does not occur in sufficient quantity to be quarried. Its influence, however is noticed, where it no longer exists, in the character of the vegetation and in the timber.

Oak timber and blue grass usually appear where the remains of this limestone still exist in the soil. Wherever this is the case, good, easily farmed and productive soils occur, as at such places as Iron City, the Allegheny and Clarion Divide, on the northern border of the township. The land along the streams in all these townships is derived from the conglomerates and is stony and rough.

PAINT TOWNSHIP

Paint township lies west of Elk and Beaver, with the Clarion River for its southern border. A high Divide between Toby Creek and the Clarion River, on the east, and Deer and Paint creeks on the west, runs diagonally across the township, with elevations above tide from 1,450 to 1,500 feet. On this high elevation not a trace of the effects of the ferriferous limestone were noticed. These

uplands are sandy and poor. The soil, at such places as Clarion Junction, though moderately rolling, is clayey, wet and cold when wet and hard, tough, cloddy and hot when the weather is hot and dry, both conditions are most unfavorable to plant growth. The soil in this township is invariably poor with usually only a scrubby timber growth.

HIGHLAND TOWNSHIP

Highland township lies east of Paint, with the Clarion River for its southern and southeastern boundary. The soil is derived from the already indicated strata.

The Clarion River and Toby Creek flow parallel southwestward, separated by a high dividing ridge along the western and southern part of which the soil is derived from the same underlying strata as that of Paint township and is, therefore, equally as poor while northward on the ridge, between these two streams, south and north of Helen, the Kittanning group remains in the higher hills, while the Clarion group and the ferriferous limestone, with a vein of from 5 to 7 feet in thickness, crops out over a larger area and forms a fairly fertile section of farming land, in the vicinity of Helen Furnace, a wonderful demonstration of the effects of the underlying strata on the fertility of the soil. Some splendid apple soils occur here.

KNOX TOWNSHIP

This township lies north of Paint and Highland and east of Elk. The soil of the township is largely derived from the underlying Clarion group of strata. The soil is more fertile, which is shown by the timber growing in the sections of the township where these strata form the basis of the soil. At Lucinda Furnace, the lower part of the Kittanning group, the Lower Kittanning coal seams, occupy the higher elevations, while, as at Helen, the Clarion group, together with the ferriferous limestone, occupies a lower and more extensive section on both sides of Toby Creek.

Here, again, are good apple and potato soils, and limestone sufficient and coal to burn it so near together, that lime for liming the poorer of these soils and make them productive can be made here at little cost. At Snydertown, in the northeastern corner of the township, the land is low gently rolling and in places wet. This land needs lime

WASHINGTON TOWNSHIP

Washington township lies north of Knox and Elk, on the Venango county line. The soil formation is similar to the township previously discussed. The Allegheny and Clarion Divide passes through it in a northeasterly course, in a ridge between East Sandy and the two

Hemlock creeks, on the north and Paint Creek on the southeast, rising about 1,700 feet above tide, and making the highest elevation in Clarion county.

In these hills, which rise abruptly above the surrounding country, are preserved the Lower Freeport sandstone, which caps the summits—which are flattened because this sandstone disintegrates easily—the Kittanning middle coal and the Kittanning lower coal with their accompanying strata, the ferriferous limestone and the Clarion group.

The ferriferous limestone girdles the hills in a vein, from 5 to 6 feet in thickness, easily quarried and in close proximity to coal veins for burning it. This limestone should and could be made one of the greatest blessings to these northern counties, including with this county, Forest, Elk, parts of Venango, Warren and McKean. Well nigh all the strata from which the soils of these counties are derived are deficient in lime. Here it seems that lime could be burned at small cost, or the limestone ground for less than it costs to burn it, and this deficiency supplied. Here, as in the other townships, with the same formation, are good clover, apple, potato, buckwheat, rye and oat soils.

FARMINGTON TOWNSHIP

Farmington township occupies the northeastern part of the county. It is the largest township in the county. The Allegheny and the Clarion Divide and the Big Level of Forest and McKean counties cross this township and make a gently rolling country.

The soil of this township, with the exception of several small sections at Scotch Hill, in the southern part of the township, Tylersburg and Haskill Station, in the west central and central part and north Pine Grove in the northeastern part, near the Forest county line, where, in all of these places, the Clarion group of strata, together with the ferriferous limestone, form the soil, is derived from the conglomerate series of strata. At Tylersburg the land is rolling and fertile and with good agricultural treatment, will produce well.

Some fairly good farming is done and the crops tell the story. The oat crop was a very good one when this investigation was made. At Haskill Station similar conditions prevail. Here the ferriferous limestone is quarried and appears to be a fairly pure stone. At Scotch Hill the ferriferous limestone occurs, in several hills, in a vein from 4 to 5 feet thick with fifteen to twenty feet of covering of shales some of which have formed a fertile soil. At north Pine Grove similar conditions prevail.

Throughout the remainder of the township, the conglomerates form clayey, sandy and stony soils, all of which should be in forest and would, at this time, be growing a second or third forest had not this land been burned over and over until roots and seeds have been weakened, and in many instances, destroyed, so that no forest growth can get a start.

But what is still worse, the protective covering of vegetable matter, which protects the roots and seed and make a more fertile soil as time went on is also burned away and the destruction of the soil has started and unless stopped within a short period of time such havoc as has been created during recent floods will be repeated and will become worse and worse.

The soil itself will go unless the crops that it produces are maintained. Such destruction is the acme of vandalism, and to their discredit be it said the railroads are the chief offenders, at least this seems to be the case throughout this section.

CAMBRIA COUNTY

Cambria county owes its existence to an Act of the Assembly, passed March 26, 1804. The territory composing it was taken from the counties of Huntingdon and Somerset. It contains 458,880 acres, of which 228,004 acres is land in farms, and of which 130,410 is improved land. 7,897 acres were planted in corn in 1909, yielding 273,346 bushels; 14,800 acres sown with oats, yielding 357,203 bushels; 3,252 acres with wheat, yielding 48,996 bushels; 6,294 acres with buckwheat, yielding 118,515 bushels; 3,572 acres were planted with potatoes, yielding 381,424 bushels; 35,766 acres were sown with all forage crops, yielding 30,757 tons of the various kinds of hay. Of the 130,410 acres of improved farm land, 74,914 were used for raising crops, while 55,496 were not used and were likely producing weeds. At this time Cambria county had a population of 166,131 people to feed, 14,085 cattle, 5,351 horses, 179 mules, 7,580 swine and 4,410 sheep.

Geologically, according to the Second Geological Survey of Pennsylvania, this county contains a small section of Catskill sandstone and shales and Pocono sandstone in the Conemaugh Valley, in West Taylor township, neither of which has any share in the formation of the soils. Mauch Chunk red shales comes to the surface, in a long narrow strip, along the Allegheny Mountain, and takes part in the formation of the soils on the eastern border of the county. The Pottsville conglomerate comes next in importance and

forms a section of very stony and rough soil, paralleling the Mauch Chunk red shale along the Allegheny Mountain and along the Big and Little Conemaugh rivers, and along Laurel Mountain, in Upper Yoder, Lower Yoder, East and West Taylor and Conemaugh townships. The remainder of the county comes within the territory of the lower productive coal measures, or the Allegheny series, and the barren measures or the Pittsburgh series.

According to the U. S. Geological Survey, the entire county is within the limits of the Conemaugh, the Allegheny and Pottsville formations. The eastern section of Adams, Summerhill, Portage, Washington, Gallitzin, Dean and Reade townships, constitute the mountain townships of this county, except the Johnstown region, with soils of Mauch Chunk red shale, conglomerate, lower coal and some barren measures.

ADAMS TOWNSHIP

Adams township, in the southeastern corner of the county, has quite a large acreage of land, too hilly and rough for farming, in the conglomerates and at such places as Dunlo, Llaufair, Lloydell and Rutherford, in the productive coal measures; all these are mining towns in the hills, where, with the exception of Dunlo, west of which, over the hills and south there is some farming and fruit growing, but not extensively. Here are soils on the hilly lands, in a community which is entirely supplied from outside sources, with all food stuffs it consumes; on which apples thrive and where all fruits could be sold readily, in the mining towns of the immediate vicinity.

Farther west at Eltonburg and Salix and as far south as Scalplevel, are gently rolling, fertile farming soils, made of the shaly barren and lower productive strata, well adapted for trucking, of which little is done at this time in this section. At Scalplevel and in the northern townships of Somerset county, considerable of this work has been done within recent years and a ready market was at hand in the mining villages of Dunlo, Llaufair, at the Henriette mines, Rutherford, a lumbering town, Beaverdale, Lloydell, St. Michaels and many other places, but more especially at Johnstown, which is connected with this section by both trolley and railroad as well as within easy driving distance.

Beginning with Portage, parts of Washington, nearly all of Gallitzin, especially in the vicinity of the town of Gallitzin, eastward and northeastward through Dean and Reade townships, is a rolling tableland 2,000 feet above tide, with soils derived from the Mauch Chunk, conglomerate, and lower productive coal strata, of greater fertility, larger in area, more easily farmed than any similarly constructed territory in the State.

These clayey, loamy, sandy, gravelly and stony soils are sufficiently fertile to support an agriculture adapted to the climatic conditions that prevail here, equal to any section of the State. At Ashville is a large outcrop of a superior limestone, which has been used for burning lime for a number of years. At Lloydell and Tigart some farming is done, oats, corn and potatoes look thrifty and so does grass but it seems for a section like this that an agriculture should be worked out, especially adapted to its climatic soil conditions.

ADAMS AND RICHLAND TOWNSHIPS.

Adams and Richland townships are similar in formation being entirely, except a narrow territory, along the Little Conemaugh, in northern Adams and another in the southeastern corner of Richland, which are conglomerate, within the limits of the barren measures of the Pittsburg series or largely in the Conemaugh formation.

Richland township, at Geistown and east of it, has rich farming soils adapted for all kinds of farming crops, and also adapted for trucking and market gardening, some of which is done here. Richland township comes to a point at South Fork, and Croyle township comes in along the Conemaugh River, and at Conemaugh Lake and as far south as Eldonburg, which seems to be, in this township, the soils are rolling and are largely derived from the yellow shale and are fairly fertile. At South Fork the soils are still rolling and derived from the same rock.

Western Croyle, Conemaugh, Stony Creek, Upper Yoder, Lower Yoder, West Taylor, East Taylor, Jackson and part of Blacklick townships, are all within the Laurel Hill structure and are hilly, and some even mountainous, and the soils, being largely derived from the lower productive rock which here are more sandy than the lower barren, which are shaly, consequently make these soils less fertile and more difficult to farm and less desirable for agriculture.

Eastern sections of Summerhill and Washington townships, at such places as Cresson, in Washington township, the soils are derived from the shales and sandstones of the barren measures or the Pittsburg series. In this section these measures are largely shales and form a gravelly, or when disintegration has not proceeded sufficiently, stony soil, and where well nigh complete disintegration has taken place, clay soils are formed. The latter soils occur in the valleys.

There are a number of types of shales in the barren measures here, one especially prevalent, forming a yellowish soil and a second, a grey and third, something like a mixture of the two; frequently the two or even the three occur in the same field and the different

capacities of these soils are shown. The one, the yellow, which predominates in Washington and Munster townships, especially on the uplands, might be termed a dry weather soil, because a drought does not effect its producing capacity nearly as much as it does that of the soils formed from shales producing the darker textured soils. The chemical agencies of disintegration, have and are acting more effectively upon the shales forming the yellow textured soil, through the processes of hydration and oxidation, than they do upon the shales and sandstone, of those forming the dark textured soils and, therefore, the yellowish textured soils hold more of the water they receive than do the darker textured soils, water that plants can extract, from the soil but which the soil does not so readily give up to the air and therefore, are better water holding soils; while the darker, are air-water holding soils. From Ebensburg, north, in Cambria township, the yellow colored types of soils prevail and where good cultivation is practiced, these soils produce well, the cereals, wheat, oats, rye and corn, when an early ripening variety is grown. At Winterset, the same soils prevail, and so on north to the turn of the Carrolltown road, northwestward. Here the grey or darker shales come into prominence. All along throughout these townships the uplands are the better farming lands.

Apple trees, unless the orchards are well cultivated, do not look thrifty and do not bear well on the yellow soils. At Carrolltown, in Carroll township, and its vicinity, the grey or darker soil-forming shales and sandstones are predominant and the hills are a little steeper and some of the soils wash readily, while the yellow soils do not wash, evidences that disintegration is slower, than in the yellow soil-forming shales and that the water-holding and saving capacity is less. In a normal season, with rain sufficient to supply the water needed by all plants, so that it is not necessary that the soil should retain a large quantity of stored water, these darker soils produce larger crops, than do the lighter colored soils, because then the disintegration of rock, and the making available of fertility can go on normally. Southeast and west of the town are several stretches of beautifully rolling land, on the darker soil forming sands and shales, producing clovers and cereal crops, equal to, or superior to the yellow shales, in all kinds of weather, because here disintegration has proceeded far enough to hold the necessary water and make available the necessary plant food. Alfalfa is raised here and looks thrifty and grows luxuriantly. At Hastings, in Elder township, is a good farming section, but the coke ovens have ruined a large section of farming land completely and its permanent destruction has begun and it will only be a question of time until more will be ruined and destroyed, unless the gases of the coke ovens are disposed

of otherwise. On the Miller farms, near Hastings, in Susquehanna township, limestone occurs and has been quarried and burned for agricultural lime for which purpose it is sufficiently pure.

BLACKLICK, BARR AND SUSQUEHANNA TOWNSHIPS

Blacklick, Barr and Susquehanna townships, on the western border of the county, have as good soils as elsewhere in the county. But farming here is somewhat in an undeveloped condition, because all the time and energy of the people, until within recent years, was devoted to lumbering, and since about all the lumber is cut, they are giving some attention to farming and both land and farms are changing, the one from producing wood, to growing agricultural crops and the other from lumbering the wood to farming agricultural crops. Some of these farms are up to the best. At Plattsville, the soil is sandy. At the Westover Settlement, in Cambria and Clearfield counties, is a good farming section, the soil largely made of the yellow shales and good farming is done here. Considerable trucking is done, especially in raising the heavier crops such as cabbages.

CHEST AND ELDER TOWNSHIPS

Chest Creek forms the boundary line between Chest and Elder townships, and makes a hilly country along the stream; but east and west of it is good farming soil made up largely of the yellow shale formation a soil especially adapted for raising wheat, rye and oats, which is evident from the crops now being raised.

WHITE TOWNSHIP

White township, east of Chest, has more hilly land than Chest, but the adaptations are very similar, because the soils are derived from the same formations and have similar adaptations.

READE TOWNSHIP

Reade township, in the extreme northeastern corner, at Lloydsville has some very good orchard soil, from the appearance of apple trees, growing there at this time. At Lloydsville, Mountaindale, Glasgow, Flynn City, Fallentimber, these same conditions prevail. South of Elder and Chest townships, at Frenchtown, in Allegheny township, on the grey or dark soil forming shales and sandstone, especially the sandstone, the soils are poor. North of this town are a number of peach and apple orchards. These trees look more thrifty and made a more luxuriant growth than any examined in other sections of the county. The soils here are largely derived from the disintegrated sandstone. These peach trees are evidently ten years old and look as thrifty as young trees usually do, but have

made only the wood growth of older trees. On the hilly land southeast of Patton and Frenchtown, in Allegheny township, in the same formation as that at Frenchtown, are soils well adapted for apples and peaches. These hills have been burned over so often that they will no longer grow a crop of forest trees and, therefore, should be planted with forest trees or should be planted with peaches and apples.

From Patton to Chest Springs, in Clearfield township, the soils are, in many places, entirely derived from sandstone. The land is hilly except at places where the headwaters of a stream begin. At such places there is usually a level or gently rolling upland of splendid agricultural soil. Several such sections occur between Patton and Chest Springs.

Chest Springs is one of the best illustrations of such a formation, because here are the heads of several small streams that flow into Clearfield Creek, which has made a beautifully rolling country of this section, not surpassed anywhere in the county. The soils are naturally fertile. Blue grass and white clover grow along the roadside, and other clovers in the fields. From Chest Springs to Loretto, the land is equally as good, if not better than between Patton and Chest Springs. In several places limy shales occur along the highway and in the fields.

At Loretto, in Allegheny township, the land is more hilly, but the soils are kept in better condition than in many other sections of the county. A limestone or limy formation outcrops along the highway, west of Loretto the effects of which are evident for some distance before and after the limestone outcrop is reached.

CAMBRIA TOWNSHIP

Cambria township lies about the center of the county. Ebensburg, the county seat, is located in this township. The town is located in an agricultural section of the township. The land is hilly. The soils are derived from the disintegration of the red and grey shales of the barren rocks, and will produce good crops of wheat, corn, oats and potatoes. West of the town, on the uplands of Blacklick Creek, is a flat and boggy formation, apparently too wet for farming but, with underdraining, would produce pasture, and the hay grasses and should either be used for this purpose or should be reforested. Beech, maple, birch some hemlock are the prevailing trees. From Ebensburg, south and southwest, both in Cambria and Munster townships, the land is hilly; but with good farming, can be made to produce well, the agricultural crops. At Wilmore, in Summerhill township, the land is rolling and produces good crops when well cultivated. The barren coal rocks are deficient in lime and, there-

fore, this element of fertility must be supplied, which can easily be done here, both from the outcropping limestone formations of the county as well as from surrounding counties.

The crops that are adapted to the soils and climatic conditions of this county, are wheat, rye, oats, corn, clovers and potatoes. A succession of crops that would yield fair returns where potatoes and clover and wheat and rye thrive, can easily be arranged. Plow clover with the rye, after the rye or wheat are harvested in July. Make hay of the clover the following year and plow sod for potatoes. In one of the northern townships, a rotation like this has been followed on a one hundred acre farm, and as high as 6,000 bushels of potatoes were raised in a normal season, for which 65 cents a bushel was realized in the local markets. The clover hay was fed, the rye straw used for absorbent, and the rye fed to the animals and all returned in the manure to the soil.

The soil, as already indicated, is formed of the more easily disintegrated lower barren coal shales, which, in this county, do not contain any of the heavy limestone seams occurring in the same series at Berlin, in Somerset county. The soils, where limy shales or even small limestone veins outcrop, as is shown near Loretto, show the benefits derived by the soil, from the disintegration of this stone, demonstrating that this element is needed in these soils and should be supplied by the farmers: The lime, it seems, could easily be gotten, at a reasonable price, from the neighboring counties of Blair, for the eastern section, and from Westmoreland, for the western. The drainage of the county is accomplished, in the northern part, beginning at the east, by Clearfield Creek, Chest Creek and the West Branch of the Susquehanna River, all flowing north from a divide crossing near Loretto and by Blacklick Creek flowing west, from north of Ebensburg, the county seat, and the Conemaugh, also flowing west across the whole county from the top of the Allegheny Mountains. The elevations above tide range about 1,400 to 2,700 feet, throughout the county, the former up to, approximately, 1,800 feet, prevailing throughout the county and the latter on the mountain ridge. Railroad facilities are good and markets the best.

INDIANA COUNTY

Indiana county was erected by Act of the Assembly of 1803, out of parts of Westmoreland and Lycoming counties. It contains 530,560 acres, of which 432,977 acres is land in farms, and of which 315,480 acres is improved farm land. 25,796 acres were planted with

corn in 1909, yielding 740,879 bushels; 25,452 acres were sown with oats, yielding 526,411 bushels; 17,045 acres were sown with wheat, yielding 220,951 bushels; 17,045 acres were sown with buckwheat, yielding 356,631 bushels; 8,960 acres were sown with rye, yielding 90,621 bushels; 4,116 acres were planted with potatoes, yielding 398,097 bushels; 48,918 acres were sown with all forage crops, yielding 42,882 tons of the various kinds of hay. Of the 315,480 acres of improved farm land, 150,590 acres were used for raising farm crops, while 164,890 acres were not so used and were likely producing weeds. At this time Indiana county had a population of 66,210 to feed, 22,748 cattle, 10,470 horses, 486 mules, 20,581 swine and 16,069 sheep.

SOIL FORMATION

Geologically, this county, according to the Second Geological Survey of Pennsylvania, contains a small section of Catskill and Pocono sand in the southeastern corner, in East Wheatfield township, and another small section in the southern borders of West Wheatfield and Burrell townships, and small sections of Mauch Chunk red shale at the same points, with additional small section on Blacklick Creek, northeast of Blacklick, or Yellow Creek, and Mahoning Creek. These lower formations do not in any way influence the formation of the soil, neither does the Pottsville conglomerate, except in the southeast corner of East Wheatfield township where it forms one of the roughest sections of the county. The formations from which the soils of the county are derived are the lower coal measures and their accompanying sands, shales and limestones. the lower barren measures and the Pittsburgh coalbed, and the upper coal measures. According to the U. S. Geological Survey, a little of the southwest corner and a small section about Blairsville are in the Monongahela formation, the northeastern and central parts of the county in the Allegheny and the eastern and western in the Conemaugh formations.

EAST AND WEST WHEATFIELD TOWNSHIPS

East and West Wheatfield townships occupy the southeastern corner of the county. Here, in the eastern section, Laurel Hill crosses the line and makes this part of the county very hilly and rough and, consequently, there is not much farming land here. Coming west the land becomes rolling and makes possible a good section of agricultural land which is, however, not as well farmed as it should be and as the locality warrants. The crest of Chestnut Ridge runs through West Wheatfield township and makes a hilly and even mountainous country in this section. The Ligonier Valley, coming in from Westmoreland county, makes a hilly but fairly fertile

country. From crest to crest of the two ridges, Laurel Hill and Chestnut Ridge, which make the sides of this valley for about ten miles between these ridges the soil are derived from the lower productive coal measures and the barren measures.

BRUSHVALLEY AND BUFFINGTON TOWNSHIPS

Brushvalley and Buffington township are in the same formation, having largely the sandstones, limestones and shales of the Conemaugh for the bases of their soils, except the western section.

The shales may be divided into several classes: Those that make a loamy soil; those that make a gravelly soil, and those that make a stony soil. The higher elevations contain the more fertile soils, especially when these soils are derived from the limy shales or the limestone such as the green crinoidal and the black fossiliferous, both of which occur in the Conemaugh formation, but are difficult to identify. But on these higher lands where the limestone and the limy shales do not occur, there usually disintegration has not proceeded far enough to make the best soils and the rough gravel or stony soils occur. In these townships on the hillsides and hilltops, the soils derived from the softer shales are loamy and those derived from the shaly sandstones are sandy and those derived from the limestone and limy shales become clay soils and are of good quality.

In southern Buffington, in the vicinity of Dilltown, the country is rough; not so much a roughness derived from the Laurel Hills, but from local hills elevated so that the lower barren measure rocks appear and, therefore, these soils are rough. These hills continue northward in this township, but between this and Strongstown, is some moderately rolling and good farming land, But on approaching this vicinity, the Mahoning sandstone appears and produces rough country to within a short distance of the township of Cherryhill and Pine which continue the same as the two townships south except that in some places they are more hilly. At Greenville, in Cherryhill township is a characteristic formation where the Conemaugh and the Allegheny join to make the soils producing one of the best and most fertile section in the county, except probably a section northeast of Blairsville. The soils will produce the regular farming crops, wheat, corn, oats, rye, buckwheat and potatoes. They are easily cultivated, respond to good agricultural treatment, and to liming, as well as fertilizer, in a gratifying way.

At Clymer, in the same township, is another characteristic point. Here the sandstones form the basis of the soil and the result is evident in the forest which, in this sandy formation, is largely made up of beech, maple, a little hemlock and a few scrubby oak, while at Greenville the white oak, the hickory and the chestnut thrive, and

little if any beech occurs. Blue grass grows along the road side. The soils are deep and do not wash. The soils of Pine township, with the coal and limestone occurring so closely together, need never be permitted not to yield the largest returns on account of not being supplied with sufficient lime.

The various townships, beginning with West Wheatfield, a section of which is within the Ligonier Valley, which have similar soils, are Burrell, Blacklick, Center, Brushvalley, Cherryhill, Green, Grant, Montgomery, Banks and Canoe. All of these townships contain outcrops of the limestone of the barren measures as at Homer. These townships, not only contains the remanents of the Ligonier Valley, in Indiana county, but also Chestnut Ridge, the watershed between the Susquehanna and Ohio rivers which here is only a narrow belt of highlands running southeast. The country is hilly, the lower productive rocks cover the surface with here and there a hill capped with the barren measures until, in the upper part of Brushvalley, the Mahoning sandstone covers the hills and valleys with massive boulders. These, together with the Chestnut Ridge and the sandstone accompanying it, have covered a large part of Banks and Montgomery townships and produced poor soils, whereas, the townships further south in this same valley (the Ligonier) have soils that are as well adapted for agricultural crops as are the valleys of any section of the county; especially are these soils adapted for raising the grasses, such as blue grass, which grows native. As soon as the forest is cleared away this grass will form the sod and take possession of the soil, and unless pastured to death, it will continue holding possession for many years.

BURRELL, BLACKLICK, CONEMAUGH AND ARMSTRONG TOWNSHIPS

Burrell, Blacklick, Conemaugh and Armstrong townships, in the southern and southwestern section of the county, are more varied in soil formation than the other townships, because these contain the Pittsburgh coal vein and, therefore, its accompanying shale, sand and limy formations. Eastern Burrell is very hilly, because Chestnut Ridge, coming in from Westmoreland county with its formations, produces hills. North and east of Blairsville, the county is hilly, but the soils are fertile, being derived from disintegrated coal shales, sand and limestones. Limestone occurs on top of the hills above the coal veins, east and north of Blairsville where it is quarried and burned to lime for agricultural purposes. Here the soils are fertile, the daisy rim and the blue grass referred to in the discussion on Somerset county occurs. No stronger evidence could be educed that soils derived from limestone or limy shales and those derived from sandstone and sandy shales are as different in fertility as the sources from which they are derived. The remaining

sections of these townships have been benefitted by the disintegration of these higher formations and their soils are more fertile. The alluvial soils of Black Lick Creek are not excelled in fertility by similar soils anywhere in the State, and are among the best for trucking or any other kind of farming. The formation along the river is usually steep, except at such places where the stream curves considerably either one direction or the other and make an alluvium or higher elevation of considerable fertility. The composition of the Sewickley limestone, occurring near Blairsville, is shown in the following analysis:

Carbonate of lime,	79.82
Carbonate of magnesia,	3.60
Oxide of iron and alumina,	3.02
Sulphur,	.11
Phosphorus,	.018
Insoluble residue,	12.16

A similar, but more extensive and fertile formation, containing the great limestone of the Pittsburgh coal bed, occurs in a number of knobs in Elders Ridge, in Conemaugh and Young townships. This formation produced one of the most fertile farming sections of the county, about nine miles long and about two to three miles wide. The effects of the disintegration of the great limestone, already referred to, are more extensive than the distances above given. The limestone and coal occur so close together on the hills here that the lime can be burned and hauled down the hills instead of up as is the case in so many places. At West Lebanon, in Young township, and some distance north and northeast of this place, the fertile soils, produced from the disintegation of the Pittsburgh coal rocks, continue. Soils are adapted for the raising of all agricultural crops and for intensive farming.

From these formations northward the lower barren rock covers the greater part of the townships of Indiana county, and are the basis of the soils occurring there. The soils of the lowhills, stretching northeast along the base of Chestnut Ridge, making the rolling and fertile uplands of Burrell, Blacklick, Center, White, Cherryhill, Rayne and Green townships, are derived from the lower barren shales and the lower productive rocks. Going north from West Lebanon, referred to above, through Armstrong township to Shelocta and thence northeastward to Five Points, the same formation continues. At Five Points a limestone bed outcrops in the bed of the creek, which has the following composition:

*Second Geological Survey of Pennsylvania, Page 159.

Carbonate of lime,	84.12
Carbonate of magnesia,	5.19
Oxide of iron and alumina,	3.22
Sulphur,	.07
Phosphorus,	.01
Insoluble residue,	6.02

From Five Points northward is a moderately rolling upland with soils derived from the barren rock, while at Plumville, west of which place the lower productive coal measures strata appear.

WEST MAHONING TOWNSHIP

The soils of West Mahoning, occupying the northwest corner of the county, are nearly entirely made up of lower barren rocks, except in the lowlands of the Mahoning creeks, which flow through this township, where the soils are derived from the rock of the lower coal formations, while near the Armstrong county line the Freeport limestone (10 feet thick) appears.

CENTER TOWNSHIP

Center township contains a considerable area of the Allegheny or the lower coal formation in the central and eastern part, while the western section is entirely in the Conemaugh or Upper Freeport and lower barren measures giving this township some sections of fertile soils as well as some that are not fertile.

At Homer, in this township, the land is low and some places spouty. Along the hills the soils are sandy and not as fertile as where the two formations combine in the making of the soils. At Graceton, the coke ovens have injured vegetation very much. South of this place a sand ridge runs across the township, or round which the creek makes a curve and forms an alluvial section of good fertility. The western section of the township is rolling and has a number of splendid farming sections upon the upland on the shales of the Conemaugh formation.

White, northern Armstrong, Washington, Rayne, East Mahoning, West Mahoning, North Mahoning and South Mahoning are all in the Conemaugh formation or the barren measures, except at a few places.

WHITE TOWNSHIP

The county town, Indiana, is located in White township, on a beautiful, gently rolling formation. East, south and west of this town are productive soils some of which need drainage. Going north and west from Indiana at Creekside, and Shelocta, the hills continue with the higher elevations, usually having the most

*Pennsylvania Geological Survey, Page 281.

fertile soil, as is the case southwest of Creekside where, on top of the hills, a limy shale formation occurs, the salient effects of which show for a considerable distance down the hill. At Chambersville, along Crooked Creek, and at Advance, the same formations continue.

At Davis Postoffice (now abolished), in Washington township, one of the valleys leading to the uplands usually of more than ordinary fertility opens and rounds up at Marion, in East Mahoning township. This is one of the farming sections of the county, with soils of good productive capacity and limestone in the vicinity to supply all that is needed. At Plumville, in South Mahoning township, and north through West Mahoning, occupying the northwestern corner of the county, the same formations continue. In a number of sections in these townships, the Mahoning sandstone, one of the poorer members of the lower barren rocks appears, as at Chambersville, in Washington township, and covers the country with massive rock as far as Kintersburg in Rayne townships producing soils not adapted to farming.

LIMESTONE

The following limestone formations occur in this county: The great limestone north of Blairsville, in Burrell township, and in Elders Ridge, in Conemaugh and Young townships. Next the limestone under the Pittsburgh coal vein, on Black Lick Creek. The Elk Lick limestone, at Covode, in North Mahoning township, which forms the soils of a part of this and eastern Canoe and East Mahoning townships noted for their fertility and for growing blue grass which at the present time abounds along the highway. The limestone of the lower barren rock, the green crinoidal outcrops near Homer, in Centre township. The black fossiliferous strata, another of the barren measure limestone occurs at the raise of the hill at Blacklick, Furnace, Kerns, Dilltown, in Buffington township, at Blairsville, on the Conemaugh, a few miles northeast of Indiana, in White township, on Blacklick Creek, near Shelocta, in Washington township, and at Smicksburg, in West Mahoning township.

The Upper Freeport limestone occurs at twenty-nine different places in the county, and in some of these places is ten feet thick. The Lower Freeport occurs at six different places and is indicated at several more, while the Johnstown cement limestone, which is rarely used for making lime, occurs at twenty different places; and where it does occur its good effects are recognized in the soil derived from it and the accompanying rock formations.

The ferriferous limestone comes up at Richmond Ridge, in Canoe township, in the valley of Little Mahoning Creek and is of such purity, as the following analysis will show, that it makes a splendid lime for agricultural and other purposes.

Carbonate of lime,	92.85
Carbonate of magnesia,	1.58
Oxide of iron and alumina,	2.03
Sulphur,	.18
Phosphorus,	.03
Insoluble residue,	2.09
	98.76

With these numerous limestone formations occurring in well nigh all sections of the county and the natural tendency of these soils to grow pasture grasses, especially blue grass, and with the special liking that blue grass has for the limy formations and for lime, and with the limestone frequently occurring on the hillsides in close proximity with the coal so that with small cost for burning the limestone can be burned and easily applied to these soils and a large part of this county can be devoted to pasturing, and stock raising, with very little cost and with great benefit to the large acreage of soils not farmed at this time.

The soils throughout this county vary from stony, on the hillsides and some of the tablelands in the gray shales to gravels, loams, and some clays in both uplands in the shales forming the red soils. The red soils seem to produce better crops normally than the gray at such places as Bookport and Dixonville, in Green township. As high as 40 bushels of wheat have been raised on the soils formed by the disintegration of the barren and lower coal rocks. Throughout these and other sections, two to three tons of hay have been raised, 100 bushels of corn on the ear, 50 to 60 bushels of oats, 200 bushels of potatoes, and 25 bushels of buckwheat. From this it is evident that these soils are adapted to all farm crops.

ARMSTRONG COUNTY

Armstrong county was formed from parts of Lycoming, Westmoreland and Allegheny, by Act of Assembly, March 12, 1800. It contains 417,920 acres, of which 355,243 acres is land in farms, and of which 266,576 acres is improved farm land. 22,552 acres were planted with corn in the year 1909, yielding 694,873 bushels; 23,192 acres were sown with oats, yielding 493,430 bushels; 15,844 acres with buckwheat, yielding 148,446 bushels; 3,859 acres with rye, yielding 36,310 bushels; 3,151 acres were planted with potatoes, yielding 288,700

*Second Pennsylvania Geological Survey, Page 264.

bushels; 46,551 acres were sown with all forage crops, yielding 41,619 tons of the various kinds of hay. Of the 266,576 acres of improved farm land, only 124,440 acres were raising farm crops in 1909, leaving 142,136 acres of improved land not raising these crops. At this time Armstrong county had a population of 67,880 people to feed, 21,975 cattle, 9,556 horses, 196 mules, 20,154 swine, and 13,009 sheep.

The outcropping geological strata of rock from which the soils of Armstrong county are derived, begin with the base of the Pittsburg coal beds, which form the soils in the southeastern section of the county, followed by the lower barren measures which covers the greatest part of this county, and from which, therefore, the largest acreage of soils are derived. The lower productive measures outcrop along the sides of the deep valleys of the barren measures, but do not take part in the formations of the soils, except in the deep anticlinal valleys and the northern section of the county and west of the Allegheny River.

The Pottsville conglomerate, the lowest formation of this county, comes to the surface only in the deep and rocky ravines of the large streams. The U. S. Geological Survey places the southern part of this county, except a small section in the southeastern corner, into the Conemaugh formation and the greater part of the northern third of the county into the Allegheny formation.

The drainage of the county is accomplished by the Allegheny River and its tributaries. The Kiskiminetas River flows along the southern border and drains that section, Crooked Creek flowing into the county from Indiana, drains a part of the county further north. The Cowanshannock drains the central part, the two Pine runs the north central and the Mahoning and Red Bank the northern, the latter forming the line between Armstrong and Clarion counties, while Buffalo Creek is the main stream of the county west of the Allegheny.

As already stated, the soils of Armstrong county, with the exception of a small area along the stream which have alluvial soils, are formed by the disintegration of the rocks upon which they rest and vary in composition as the rocks vary.

The county may be divided into three sections: First, the narrow strip of upper productive coal measures, in the southeastern corner; second, the townships covered by the barren measures, and, third, those sections where both the barren and the lower productive coal measures come to the surface, and these two combine in forming the soils.

The eastern sections of Kiskiminetas and South Bend townships have soils derived from the upper productive coal measures. These soils are rolling, some few hills, but are not undesirable because

they contain limy shales and the disintegration going on here spreads its salient effects upon the soil below for a considerable distance and, therefore, not only keeps the hilltops limed where it is difficult to put lime, but also the hillsides, some of which are equally difficult to reach. Deeper plowing will keep up the supply of lime in these soils made of the limy shales for a long time. The "Great Limestone" formation, so extensive in the Pittsburg coal measures, remains in only one place at Elders Ridge in the hilltops, but its effects are noticed on other hills where it no longer remains.

The Sewickley limestone, another of the upper productive coal measure limes exist in the Coalport cliffs and where it outcrops, makes its influence effective in the soil formation.

The Pittsburg sandstone is somewhat similar to the Great Limestone in this section, in, that it has disintegrated, except at Coalport where it forms a cliff near the top of the hill. These hilltops are fertile and well nigh inexhaustible when treated well agriculturally.

All regular farm crops will thrive in these soils as will also market gardening crops. The same bending of the rock that made the trough in which was preserved the Great Limestone and the Pittsburg coal bed in this southeastern section has taken place over the entire county.

The basin or the trough in which this formation occurs, extends west to Long Run, but the higher rocks remain only along the eastern part of this county, while westward to Long Run and beyond, the lower barren rocks cover all the hills and many of the valleys of Kiskiminetas and Allegheny townships and, therefore, nearly all the soils of this section are derived from these rocks.

This entire group of rock comprising the lower barren is about 550 feet thick and has some forty members in the southeastern section of the county, according to the Second Pennsylvania Geological Survey. The rocks of this formation do not disintegrate as readily as do the rocks of the coal measures, therefore, the soils are shallower. They are also made and kept more shallow by washing. They are deficient in lime because in the nearly 600 feet of forty different strata there are only three strata in this county that contain lime or are definite limestone strata and in many places these do not appear or have been replaced by sandstone or shales.

The same curving of the strata that produced a trough or basin in which the Pittsburg coal was preserved in the southeastern corner of the county has taken place throughout the entire county. These basins or troughs have a northeastern and southwestern course.

The effects on the rock is seen in the curves of the Kiskiminetas River as well as in the curves in the creeks flowing westward in the interior of the county. Not only are their effects noticeable in the curves of these streams, but also on their valleys wherever the

streams are crossed by a trough or basin there the valley widens and its banks recede and where it is crossed by the sides of a trough or bain there the valleys narrow and sometimes become gorges. This is true especially in such formations as Armstrong county.

Not only do these anticlines and synclines, for so they are named, bring up lower rocks, geologically, into higher elevations and keep higher rock formation, geologically, in lower position, but the rock formation gradually rises from the Kiskiminetas River northward, until, in the northern part of the county, the rocks, which are covered under 550 feet of barren measures, in the south, occupy well nigh the whole surface and those that were dominant in the south occupy only isolated patches on the hilltops. All of which is evident in the soils in the various sections of the county. As already stated, the barren measures cover the surface of Kiskiminetas and Allegheny townships (Allegheny township is now divided into three townships, Gilpin, Bethel and Parks). In this section, therefore, the rocks from which the soils are derived in the northern part of the county come above the river as a whole only in one place, at Roaring Run, where one of the sides of the basin, referred to, crosses the river; but they do not take part in the formation of the soil and their salient effects are not manifested in the southern section of this county. Plum Creek, the northern part of South Bend, Burrell, southern central Kittanning and Manor have soils derived from the same rock strata. The country in these townships and parts of townships, like all the southern townships, is very hilly and farming is attended with difficulties. The lower barren rocks overspread all the highlands, and in the vicinity of South Bend all the lowlands.

But going west from this place along Crooked Creek the first formation interesting to agriculture appears in the Freeport upper limestone which has been quarried and likely burned into lime. Still further west the ferriferous limestone rises above the water in Crooked Creek so that here well nigh the whole of the lower productive rock come above water level, but not sufficiently to make all its good effects as far reaching as might be desirable.

An analyses of this limestone shows that it is of good quality and will supply the deficiency of lime in these soils.

Pa. 2nd. Geo. Survey H 5 Page 64.

Carbonate of lime,	94.18
Carbonate of magnesia,	1.48
Oxide of lime and alumina,	2.08
Phosphorus,	.03
Insoluble residue,	2.10
	99.87

Between this place and Cochran Mills, in the valley of Crooked Creek, the limestone, already referred to, after disappearing, again comes up and rises above the valley of Crooked Creek as well as the valleys of some of the small streams flowing into the creek, again to disappear and not to again reappear along this stream until it flows into the Allegheny River. Along the road going westward to Cochran Mills, in several places, the limestone crops out, likely the Freeport upper and lower, both of which enter into the formation of the soil, producing some splendid sections, especially on the road to Elderton, northward, where one of the quite extensive plains is formed by the disintegration of these lower coal bearing shales, limy shales and limestone.

The soils of central and eastern Plumcreek township are largely made of the barren measures. Along Plum Creek, in the eastern part of the township, the formations alternate, now they are lower barren, and again lower productive rocks, and in consequence of this the soils also change from more fertile on the productive to the less fertile on the barren rock formation. This is a characteristic condition, except at Elderton, where a limestone formation outcrops along the hills and produces a fertile and productive soil, easily farmed, not stony but loamy in character. From this town to Weisburg, along the Indiana Road, the soil changes from this limestone formation, through the shales, to the Mahoning sandstone, along Cherry Run, and is shaly, stony and thin and infertile, in harmony with the rocks from which it is derived.

From Whitesburg or Wiesburg westward through Kittanning township, the land is very hilly and the soils well nigh entirely derived from the lower barren coal rocks which, through this section, contains little limestone in its structure. From Cochran Mills westward to the Allegheny River, as well as in a few places eastward along Crooked Creek, are high, almost vertical cliffs, followed by valleys of considerable breadth of fertile meadow lands, some stretching away to moderately sloping hills on both sides of the stream, but more frequently with a steep hill on one side and the moderately rolling formation on the opposite side of the stream. Along the State Road southeast of Kelly Station, at the schoolhouse east of the road, is one of the barren limestone formations, outcropping, along the hills which here, as elsewhere, enters into the formation of the soil as is evident from the crops and trees.

Cowanshannock, northern Kittanning, northern Manor and Valley townships, have very similar soil structures. Going northward from Elderton to Centerville, the gentle rising of the rock strata northward, already referred to, becomes more evident in the valleys

of the streams, both of those flowing southward into the north branch of Plum Creek, but more in the streams that flow northward into the Cowanshannock.

In many of these valleys, instead of the beech, the birch, the maple, and sometimes the pine, occupying the valleys as they do southward, they grow on the hillsides and the hilltops in the barren formation, and the white oak, rock oak, black oak, and sometimes the hickory, occupy the valleys showing that a richer soil exists here. These valleys are also wider and their hillsides more moderately rolling and farming can be more easily done than in the barren measures further south.

At Centerville is a rolling formation, some of it too low and wet for farming. But there is very little of this kind of soil. Going westward from Centerville to Rural Village, the same formation continues; but at Rural Village, the lower productive rock appear, while the barren measures occupy all the uplands. Further west from Rural Village, at Greendale, and at Smith's Schoolhouse No. 2 Valley township, one of the curves upward in the rock strata occurs, and the whole series of lower coal rock is brought up and forms the soils of the hillsides and the limestone, the Freeport upper, outcrops along the hillsides and even reaches the hilltops in many places.

At Smith's Schoolhouse No. 2 along the hillsides this limestone is quarried and burned into lime likely for agricultural purposes. There are numerous places along the upper and lower hillsides where the limestone strata, the Upper and Lower Freeport and the ferriferous outcrop in this Cowanshannock Valley so that the supply of limestone here is well nigh inexhaustible. Further west along this same valley in the vicinity of Tittles School No. 2, on the Clearfield Pike, the limestone again outcrops along the hills and produces a fertile soil upon which is still standing some enormous oak timber.

Here it seems the coal and limestone occur so close together that the lime could be burned at little cost. The valley of the Cowanshannock throughout these townships in many places is narrow and steep, while in others it is broad, with meadow lands along the banks and moderate slopes rising to the uplands.

The uplands between the Cowanshannock and Crooked Creek forms a Divide, extending through the townships, upon the barren rock, the more easily disintegrated of which have, in these uplands, formed some very desirable soils, such as occur along the Indiana Pike, which partly follows this Divide and finally crosses it.

These are the apple soils of the county, and also the pasture grass soils where they are deep. Blue grass grows and thrives in many places. The same thing is true in some of the broader valleys where the deeper disintegration has taken place and where limy shales and limy strata exist. The soils of this valley and of the uplands

both of barren and lower productive rock formations contain sections of the highest natural fertility, with few sections, not sufficiently fertile to support agricultural plants.

North of the Cowanshannock, at Barnards, near the Indiana county line, in northeastern Cowanshannock township as well as in southeastern Wayne the lower barren rock prevail as far north as Dayton. The high knob near Barnards contains a limestone formation of considerable proportions, easily accessible, which can readily be burned into lime and should be used in this vicinity. South of Dayton and from Barnards northward the soils are formed of a soft shale of the barren rocks and are, consequently, smooth, loamy and easily farmed and productive when treated well, agriculturally. The same is true of the Boreland and Russell settlements in this vicinity

The Divide between the Cowanshannock and South Pine creeks is narrow and hilly. Wayne, Boggs, Pine, Madison, Mahoning and Redbank townships form the northern or third soil section of Armstrong county. The soils of this section are largely derived from the disintegration of rocks of the lower coal formations, with some conglomerate along the streams. The lower barren measures, which cover the uplands south of eastern Wayne, parts of Boggs and Pine, and northeastern Mahoning with many smaller sections scattered over these uplands of each of these townships, produce soils of fair productive capacity.

The rise of the rock strata northward has here attained such an elevation that the larger part of the barren rocks have disappeared and the lower coal measure rock with their limestone strata intermingling with the lower strata of the barren rock form the soils from South Pine Creek to Red Bank Creek, the northern boundary of the county.

Along the south fork of Pine Creek, from Dayton southward, already referred to, the lower barren rocks prevail, while from Dayton, northward, the whole of the barren rocks have disappeared, so that all of the central Wayne township is covered with the lower productive coal measure rocks. The same is true from Echo, on South Pine Creek, northward, while between Echo and Dayton, along the north branch of South Pine Creek, westward some barren rocks remain. Along this section the Freeport upper limestone outcrops some distance northeastward from Echo and enters into the formation of the soil, as well as furnishes an easily accessible limestone for agricultural purposes.

This section of the county is hilly, but contains some splendid upland soils. Along the north of South Pine Creek are a series of low hills forming a Divide between it and Scrubgrass Creek, which hold fertile soils, well adapted for raising all agricultural plants.

The Divide westward between Pine Creek is hilly, but some fertile uplands exist here, all in the lower productive rocks, until Boggs township is reached, where, in the vicinity of Slabtown, the barren rocks again appear on the hills and form the soils. Along these hills the Upper Freeport limestone outcrops and is of sufficient thickness and purity to quarry for agricultural lime. The Mahoning sandstone forms the top of these barren measures and, therefore, little need be said about agricultural conditions here. Along South Pine Creek are some uplands, as well as some valley soils of good fertility and produce well all farm crops. The ferriferous limestone extends from Echo to Pine Creek Furnace, a distance of probably 10 miles, of which the analysis given herewith will show the composition.

H 5 Page 121, 2nd. Pa. Geo. Survey.

Carbonate of lime,	96.78%
Carbonate of magnesia,	1.27%
Oxide of iron and alumina,	1.06%
Phosphorus,	.02%
Insoluble residue,	.37%
	99.50%

This is a very pure limestone.

The central section of Boggs township, along North Pine Creek, has some good upland soils, well adapted for fruit raising as well as for general farming. Along Pine Creek, in many places, the banks slope more moderately, and some good farming sections occur, adapted to agricultural crops. Along Scrubgrass Creek, the country is very hiliy, the outcropping rock strata, extending from the Pottsville conglomerate to the Mahoning sandstone.

Redbank township lies in the northeastern corner of the county along Red Bank Creek. This is a very hilly region, with some very fertile soils on some of the uplands thus formed. The ferriferous limestone outcrops along the entire northern border of the township and has been quarried at such places as Maysville and Oak Ridge. The Upper Freeport limestone outcrop along the hills and forms a section of the fertile upland soils, already referred to. This same formation continue on the hilltops wherever oak timber prevails, as is the case in many places. As far as and beyond New Salem, southward and eastward, to Freedom, extending into Indiana county, along the streams such as Little Mud Lick and Mud Lick creeks, are steep hills which continue along the larger streams, as at Eddiville, on Pine Creek, and Putneyville, on the Mahoning.

MAHONING TOWNSHIP

Mahoning township lies west of Redbank. The central section is covered with the lower members of the lower barren series. The Mahoning sandstones occurs at Putneyville; and is said to be 75 feet thick—it at least seems to be that thick—and, as usual, the soils are lean wherever it occurs. Here also, under the sandstone, occurs the ferriferous limestone in the railroad cut and is good quality. In some sections where the sandstone becomes shaly better soils prevail.

From Putneyville to Oakland, on top of the hills, are some of these soils, apparently the best fruit soils in this section made of the Mahoning sandstone. These are beautifully rolling uplands.

From Oakland to Kellersburg, these upland formations continue, but pass from the sandy soils, produced by the disintegration of the Mahoning sandstone into the shaly soils of the lower coal measure rocks. This transition is difficult to notice until it is complete. From Kellersburg, westward, on the Divide between Mahoning and Red Bank creeks, Madison township, the lower productive rocks except some isolated places, make the soil. Some of the best apple and potato soils of the county are found in this section.

The following townships of Armstrong county lie west of the Allegheny River, beginning at the north with Perry, Bradys Bend, Sugarcreek, Washington, East Franklin, West Franklin, North Buffalo and South Buffalo.

PERRY TOWNSHIP

The northern section of Perry township is referred to in the discussion of Butler county. Along the river the hillsides are steep, and there is little agricultural soil in the river valley. The uplands, in southern Perry township, are hilly and, in many places, stony and rocky, but wherever the lower barren coal strata form a thin covering on lower productive coal formations, the land is more rolling, and the intermingling of the two formations makes a more fertile soil and one more easily farmed than when formed of the barren shales entirely.

The ferriferous limestone outcrops along the river from Bear Creek, south to the limits of the township. At Monterey, it is 8 feet thick and of good quality. At Hillville, it is about 280 feet above the river, extends back into the ravines made by the small streams flowing down from the uplands already referred to.

BRADYS BEND TOWNSHIP

Bradys Bend township lies south of Perry along the river. The celebrated Bradys Bend extends into this township, with its high cliffs. The territory enclosed by the Bend belongs to Clarion county.

The strata which form the soil of this township, range from the shales above the Freeport coal formation down through the conglomerates. These latter do not, however, take part in the formation of the soils.

Sugar Creek and its branches form many ravines in this township making much hilly land. Between these ravines on the uplands are some good farming soils formed in many places of the more easily disintegrated shales. It seems that in this and Perry townships should be the locality for raising apples.

SUGARCREEK TOWNSHIP

Sugarcreek township lies south of Bradys Bend, on the Butler county line. The strata of this township extend from some distance above the Mahoning sandstone down beneath the ferriferous limestone, except where the township touches the river. The Mahoning sandstone covers the hillsides in the vicinity of and to the east of Greenville, and makes rough and poor soils. Westward of this place the same formation becomes more shaly and makes a better soil.

The Divide between Sugar Creek and its branches and Buffalo Creek, passes through this township and, consequently, some rolling highland is formed, some of which is adapted for grazing, especially. The soil is fairly fertile, and with good farming, can be made productive. The southern section of this township, along the North Branch of Buffalo Creek is within the lower productive coal formation. Here the soil is rough and stony, except the rolling uplands, where disintegration has proceeded further and where the strata are more easily acted on than upon the lower levels and therefore the soil is more fertile.

WASHINGTON TOWNSHIP

Washington township lies east of Sugarcreek and southeast of Bradys Bend, along the west side of the AlleghenyRiver. The lower productive coal strata are the surface rock of nearly the whole of this township and form soils very similar to those of Madison township, already referred to. These soils should be well adapted to wheat, potato and clover raising

The Divides between the streams in the northern part of the township are narrow and, in many places, steep. The ferriferous limestone comes to the surface at Hulings Run, and thence, southward, along the river. The uplands in the central and southern part of the township are more moderately rolling and are easily farmed and productive and are adapted to raising the regular agricultural crops.

WEST FRANKLIN TOWNSHIP

West Franklin township lies south of Sugarcreek, along the Butler county line. In the northwestern corner, the lower barren strata form the soil, while from there southward until the southeastern corner of the township is reached, the lower productive formation occupies the entire township. In the vicinity of Craigsville the conglomerate strata are brought up by an upward curve and form steep slopes along Buffalo Creek.

At Worthington, in the vicinity of the woolen mills, these strata are above the streams, but do not enter into the formation of the soil. On the uplands in the vicinity of Worthington, the ferriferous limestone occurs and enters the formation of the soil on these uplands. West of this place, at Buffalo Furnace, and still further westward, this limestone takes part in the formation of the soil. The land at Worthington is moderately rolling, fertile easily farmed and productive.

The soils of the southwestern and southern sections of the township are formed of the strata above the limestone and are equally rolling and fertile. These soils are adapted to the raising of all agricultural crops.

EAST FRANKLIN TOWNSHIP

East Franklin township lies east of West Franklin, along the Allegheny River. In the northern part of the township is a Divide between Glade and Limestone runs, upon which the soils are derived from an intermixture of the barren and lower productive strata which makes a fertile soil. Nearly all of this township, except along the river, and a few of the streams, is moderately rolling, with fertile soils; especially is this the case along the road from Kittanning to Worthington, and immediately west of Kittanning, on the hills above the river, where a limy shale forms the soils, some of which are loamy, gravelly and some sections clayey but all very fertile.

Alfalfa has been raised here for sometime with the most gratifying results. Four tons per acre of clean alfalfa hay have been produced on these soils.

Along Glade Run, in the central part of the township, especially on the higher elevations above the run, are the smooth glade lands, from which the run takes its name. These soils are fertile and easily farmed, especially adapted for raising the hay grasses. The limy shales are better adapted for raising potatoes, wheat and the clovers.

NORTH AND SOUTH BUFFALO TOWNSHIPS

The former lies directly south of East and West Franklin and the latter south of the former. Glade Run flows through the north

section of North Buffalo, and the configuration of the land, already discussed in East Franklin township, continues along the uplands of this stream in this township.

The strata are all of the lower barren coal formation, except along the run, where the lower productive formation makes the basis of the soil. The green crinoidal limestone, which is about the middle strata of the lower barren series, occurs in the hills near Slate Lick, and beneath it the red ferriferous shale, which usually forms a tough clay soil of little value.

The uplands on the Divide between Glade Run and Nicholson Run are moderately rolling and of fair quality. The same is true of the Divide between Nicholson and Pine Run. The rolling uplands of North and South Buffalo townships are similar to those throughout this region wherever the lower barren strata are the basis of the soil, which are loams, silt and clay loams and when well farmed, will produce large crops.

What the more fertile of these soils, of which there is a large acreage in this county, can, with good farming, be made to produce has already been indicated. What has been said of alfalfa is equally possible with timothy and clover hay, as well as with rye, wheat, corn, oats, especially in the fertile sections of the county. Rye should be raised in many of the thinner and deficient in lime soils.

BUTLER COUNTY

Butler county was formed from the county of Allegheny, by Act of the Assembly, March 12, 1800. It contains 505,600 acres, of which 413,167 acres is land in farms, and of which 310,039 is improved farm land. 24,716 acres were planted in corn in 1909, yielding 801,593 bushels; 30,550 acres sown with oats, yielding 758,941 bushels; 18,234 acres with wheat, yielding 276,087 bushels; 10,462 acres with buckwheat, yielding 175,668 bushels; 1,968 acres with rye, yielding 22,061 bushels; 5,444 acres were planted with potatoes, yielding 532,321 bushels; 67,865 acres sown with all forage crops, yielding 78,419 tons of the various kinds of hay. Of the 310,039 acres of improved farm land, 159,229 were used for raising crops, while 150,810 were not so used and were likely producing weeds. At this time Butler county had a population of 72,689 people to feed, 29,610 cattle, 12,243 horses, 200 mules, 22,231 swine and 21,123 sheep.

Butler county lies west of Armstrong, south of Venango and Mercer, east of Beaver, Lawrence and Mercer and north of Allegheny county. The outcropping rock strata which form the basis of its

soils range from the conglomerates to the strata of the lower barren coal measures. The northern half of the county is, geologically, lower than the southern half, but topographically, it is higher. The county therefore, divides itself into two parts, the northern having the outcropping rock strata of the lower productive coal measures and the ferriferous limestone and the southern, the lower barren strata, with few if any outcropping limestone or limy shales. The Divide between the Allegheny and the Beaver rivers passes through this county, turning the water flowing into the former streams, except Buffalo Creek, through short, narrow, steep and rocky streams into it, while Connoquenessing and Crooked creeks, emptying into the latter, are large streams and flow over more gentle slopes. The elevation above tide varies between 1,500 feet on the Divide and 750 feet in the southeastern corner of the county.

BUFFALO TOWNSHIP

Buffalo township occupies the southeastern part of Butler county. The soils of this township are derived largely from the Buffalo and Mahoning sandstones, the lowest sandstones of the barren coal measure strata. The channels of Big and Little Buffalo creeks are perfect gorges cut down through both these sandstones making wild and picturesque scenery, with poor, rough, and stony soils, difficult to farm.

At Monroe Station, along the eastern boundary of the township, the country is rough and hilly, and the soil, formed of sandstone, is not productive, and should be allowed to remain in forest. In the gorge along Buffalo Creek, a vein of limestone occurs in such a position that it could likely be mined and lime made of it by using the coal of a coal vein underlying it.

The soils of the southern section are entirely different from the northern and central parts, because they are derived from the softer and more easily disintegrated shales of the barren rock strata and are rolling; and, also, because the crinoidal limestone occurs in many places in this section, especially on the hills, and enters into the composition of many of the soils. These soils produce well all agricultural crops.

Underlying the crinoidal limestone is a red, sometimes yellowish colored shale which, when decomposed, forms a stiff, tenaceous barren difficult to farm, soil of little agricultural value.

CLINTON TOWNSHIP

Is very similar to Buffalo, the northern and central parts being entirely underlaid with the lower barren strata, except that the Buffalo and Mahoning sandstone, wherever they occur, are not

as massive and do not cover so extensive a territory. The uplands are rolling, being formed of some of the more easily disintegrated lower barren strata below the crinoidal limestone. These soils are usually not fertile, but with careful farming and by the use of lime, and manure, especially manure, and some commercial fertilizer, can be made productive

The Divides between Bull Creek, Thorne Creek and Sarvers Run is made in the northern and northeastern sections of this township. This makes a moderately rolling upland of gravelly, some stony but mostly loamy soils of fair fertility; but, as already stated, demand good agricultural treatment.

MIDDLESEX TOWNSHIP

Middlesex township lies west of Clinton on the Allegheny county line. The rock strata underlying the soils of this township belong to the lower barren coal series, beginning with the crinoidal limestone which belongs about the central part of these strata and extending downward to the Mahoning sandstone which occurs on the south branch of Glade Run in the southern part of the township.

All the intervening strata, including the crinoidal limestone, are easily disintegrated and, therefore, the land is rolling and the soils composed largely of the underlying rocks are loams and clays where the softer shale rocks existed and sands where the sandstone strata disintegrated. The barren strata are usually deficient in lime, but here this deficiency can be supplied by either crushing and grinding the crinoidal limestone and applying it as the crushed limestone to the soil or by burning it and applying it as the burned lime.

Sufficient limestone and coal can frequently be gotten on the same farm to burn and furnish all the lime needed for a large community of farmers. With the application of lime and manure and the plowing down of heavy sods such as these soils will produce, this township can be made a hay and pasture raising section of large capacity. A rotation of crops should be introduced that will accomplish this end and which can readily be worked out for the various soils.

ADAMS TOWNSHIP

Adams township lies west of Middlesex along the Beaver county line. The barren series of strata extending from the crinoidal limestone down to the Upper Freeport coal along Breakneck Creek in the northwestern section of the township, underlie the soil and form the basis of the structure. These strata contain none of the hard sandstone of these series and, therefore, disintegration has proceeded until broad level valleys have been formed along the streams with moderately rolling uplands along their sides producing soils that

are easily farmed and with the treatment already given for Middlesex township will produce well. In the southern section of the township the green crinoidal limestone occurs in well nigh all the higher elevations. In several instances lime of good quality for agricultural purposes has been burned of this stone. As already indicated, in Buffalo township the red clay shale occurs under the crinoidal limestone and forms soils that are about as barren as they can be, and if located around hills, can easily be recognized by the scanty vegetation they produce. This township, like Middlesex, has splendid hay and pasture soils which will produce large crops if well treated.

CRANBERRY TOWNSHIP

This township occupies the southwestern corner of the county. The outcropping strata range from the middle of the barren series down to the Upper Freeport limestone along Brush Creek in the southwestern corner of the township.

This limestone does not take part in the formation of the soil.

Throughout the northern and western part of the township the lower barren rock yields so readily to the disintegrating agencies that no steep hills remain and the country is usually gently rolling, forming soils of clay and loam, easily farmed and with good farming will produce well, especially the hay grasses. In this township the Brush Creek limestone outcrops along Brush Creek, whence its name, and takes part in the formation of the soil.

WINFIELD TOWNSHIP

Winfield township lies north of Buffalo on the Armstrong county line. The rock strata outcropping in this township range from the barren coal measures down to the Piedmont sandstone on Rough Run in the northeastern part of the township. Along this run the ferriferous limestone, in a massive cliff with a thickness of from 16 to 18 feet, outcrops. This stone was formerly used for furnace flux and is noted for its purity and whiteness. The Clarion coal bed occurs so close to the limestone that with little handling the limestone can be burned with this coal at small cost and applied to the soils. Ascending this stream numerous strata outcrop but do not enter into the formation of the soil until the northeastern corner of the township is reached. Here are some limy strata that produce a richer soil adapted to raising potatoes, wheat, corn, and the clovers.

Between Buffalo and Rough Run the Buffalo sandstone forms a rough, rocky and stony country, especially along the streams where large bowlders have been detached and cover the slopes. On some of the uplands and also along some of the streams where this sandstone does occur the soil is less stony and makes fairly good farm-

ing land, as at Cabot Station, the land is stony but can be farmed. At Marwood the land is more moderately rolling, less stony and fairly fertile.

White oak timber thrives here and makes trees of considerable height and size therefore the soil must be naturally fertile. At Saxon similar conditions prevail. The central and southern parts of the township is covered with the barren strata from the middle southward.

JEFFERSON TOWNSHIP

Jefferson township lies west of Winfield and north of Clinton. The outcropping strata range from the crinoidal limestone down to the Freeport coal which comes above water along Thorne Creek near the eastern border of the township. Here the creek along its course produces a rough country compared with the rolling land in the vicinity of Saxonburg and throughout the central part of the township. Along the uplands and the smaller upland streams, at Great Belt in the northeastern part of the township, this rolling land continues until Rough Run is reached, when it becomes more stony. The barren shales and sandstones from which the soils are derived disintegrate easily and as usual clayey and sandy soils are formed.

The green crinoidal limestone remains in several hills near Jefferson Center making fertile soils. Under this limestone the red shale which forms a red tough clay soil difficult to farm and well nigh unproductive occurs. From a few tests made, it is evident that the unproductiveness of these red clay soils is not due to the absence of the elements of fertility but to the absence of a physical condition essential for growing crops. A comparatively heavy application of coal ashes, about 100 bushels to the acre together with manure or vegetable matter will make these soils productive. Ground limestone will have the same effect and if it can be obtained should be used together with the manure and the vegetable matter. Crushed limestone will do wonders for all the clay and sandy soils of this county except likely in such places where the soil is derived from disintegrated limestone. From Jefferson Center southward Thorne Creek enters the lower sandstone of the barren measures, and when it passes out of the township into Penn township the Buffalo sandstone outcrops 120 feet above the bed of the stream, making an entirely different topography in this corner of the township from that of the eastern and the northern and southern sections, which are moderately rolling. Along many of the smaller streams the land is frequently rocky and stony, while the upland soils are loamy and sandy. These loamy soils are found in the vicinity of Saxonburg, which is located in one of the best barren shale farming sections of the county.

PENN TOWNSHIP

Penn township lies west of Jefferson and north of Middlesex. The southern section of this township is similar in formation to Middlesex, already described. Along Thorne Creek the structure is the same as that of Jefferson, previously referred to. The crinoidal limestone occurs in a knob along the Butler Pike south of Thorne Creek.

The Buffalo sandstone occurs near the mouth of Thorne Creek extending around hills from which large masses have fallen to the valley. The same sandstone forms high cliffs north of the Connoquenessing from which masses of rocks the size of houses have fallen and the place is known as "Town Rocks" otherwise the township is moderately rolling and the soils similar to those of the barren coal measures.

FORWARD TOWNSHIP

Forward township lies west of Penn and north of Adams. Connoquenessing Creek enters the township at the northeastern corner and flows in a very circuitous course to approximately its center, changes its course, flows directly north then westward out of the township at the northwestern corner. As already indicated in Penn township, the Buffalo sandstone continues covering the surface of the high cliffs along this stream. The same is true of Glade Creek at the mouth of which the Buffalo sandstone occurs and beneath it, the Mahoning sandstone forms the steep cliffs. Breakneck Creek flows across the southwestern corner of the township, and it, too, has cut down to the Freeport coal so that in this township the strata range from below the middle of the barren measures down into the lower productive coal strata.

The farming land of this township is largely confined to the hills above these streams, many of which are moderately rolling and some fairly fertile, but wherever the Buffalo sandstone covers the surface the soils are not adapted to farming, and should either be kept in pasture, if such a thing is possible, or in forest. Between Glade Creek and Breakneck east and west of Evansburg is the moderately rolling land of these barren rock, needing lime and good cultivation to make it productive.

JACKSON TOWNSHIP

Jackson township lies west of Forward on the Beaver county line. The Connoquenessing Creek flows through the northern section of this township from east to west. Near the center of its course through the township Little Connoquenessing empties into it from the north and Breakneck Creek from the south. These streams have eroted broad valleys down to the strata of the lower coal formation and have changed the topography of this township in such a way that the massive sandstone which are so conspicuous along the streams in

Forward township are here only found on top of the hills away from the streams and are not massive but have yielded to the agencies of disintegration so that sandy soils are formed that will produce with liming and manure, fair crops, such as potatoes, buckwheat and rye. The strata of the lower coal measures in many places of the valleys, along streams above referred to are limy and form the most fertile and productive soils in this county or any other county; especially is this the case at such places as Harmony and Zelienople. Here are among the best dairy soils anywhere in the State and in this section should be used for this purpose.

LANCASTER TOWNSHIP

Lancaster township lies north of Jackson along the Beaver and Lawrence county line. The rock strata in this township extend down into the Darlington coal in the lower coal formation. The streams in this township have not formed as broad valleys as in Jackson township, but sufficiently broad to make some fertile valley rolling land along their courses on the strata of the lower productive coal rocks adapted to dairying or the raising of all agricultural crops that will thrive in this section. The uplands on the barren strata are rolling but more stony than Jackson township.

CONNOQUENESSING AND BUTLER TOWNSHIPS

Connoquenessing and Butler townships lie, the formed east of Lancaster and the latter east of the former. The banks of the Connoquenessing are usually steep and there is little farming land along this stream. Between Crab Run and the Little Connoquenessing the lower barren shales form an upland, with some good farming soils, especially in the northwestern corner of the township. The best farming soils in these two townships lie between the Big Connoquenessing and the Little Connoquenessing and cover the southeastern section of Connoquenessing and the western and northwestern section of Butler.

This is a gently rolling country, with white oak timber, with soils of better quality than the barren shales soils usually are, adapted for raising the hay grasses, but not sufficiently turned into clays not to be adapted for raising potatoes which do very well in many parts of this section. Some market gardening is being done here. Berry growing is made a specialty by the farmers throughout this section and has become a successful industry. The soils seem especially adapted for this business and large returns are realized. East and southeast of Butler the Buffalo sandstone covers the country and the land is rough and a considerable acreage not adapted to farming, especially is this the case along the streams.

SUMMIT AND CLEARFIELD TOWNSHIPS

The former lies east of Butler and the latter east of the former on the Armstrong county line. The best land of Summit township lies in the southeastern corner in the vicinity of Herman and as far north as Brinkers. East of this place is one of the gently rolling uplands, with soils derived from the softer barren strata, of good agricultural capacity, which, with good agricultural treatment, yield paying returns. Clearfield is hilly and cut up by streams in the northern and southern sections, while the central part contains one of the rolling uplands adapted to the same crops as Summit.

The soils of northern Butler county are derived from softer and more easily disintegrated rock strata of the lower barren measures largely confined to Muddycreek, Franklin, Center, Oakland and Donegal townships, while the soils derived from the Mahoning and Freeport sandstone are largely confined to the highlands of southern Brady, Clay, Concord and Fairview townships. The soils derived from the disintegrated rocks of the lower barren coal measures covering four-fifths of this part of the county, are confined more to the valleys in the townships above referred to, while in the northern townships they underly the entire country. The fertility of these soils depends largely upon the underlying rock strata, if these contain limy shales or limy cementing materials and some sand the soils are naturally fertile, easily farmed and kept in productive condition. But where the easily disintegrated shales with but little lime form the clay soils of the district they are difficult to handle and make a profitable agricultural operation questionable. White oak and red oak, with some chestnut and a little pine and beach are the prevailing forest trees in all these townships.

This section differs from southern Butler county, in that it has bottom land along the streams such as Muddycreek and Slippery Rock Creek, formed largely by glacial action on the accompanying hills which have been leveled and the valleys filled paralleling them. These soils are sandy, sandy loams and clays. The sandy loams and some of the finer sandy soils make some of the best gardening soils in the State and should be used for this purpose or for the dairy industry while the clays should be limed, underdrained and used for raising the grasses.

The first tier of townships embraced in northern Butler county are Muddycreek, Franklin, Center, Oakland and Donegal.

MUDDYCREEK TOWNSHIP

The outcropping rock strata of Muddycreek township extend from the Mahoning sandstone, which occurs in the highest elevations, down to the top of the ferriferous limestone which outcrops ex-

tensively north of Muddycreek. This stone has been quarried along this outcrop for a long time. It makes a clean lime adapted for agricultural as well as for all other purposes for which lime is used.

The southern section of this township is hilly and the soils on the hills and hillsides are not specially fertile because the Mahoning sandstone underlays the hilltops and because the limestone strata of the lower coal measures, with the exception of the Upper Freeport limestone, which is quite impure, are absent from the soils of the hillsides. The bottom lands along Muddycreek are usually fertile well adapted for gardening crops as well as for all agricultural crops.

FRANKLIN TOWNSHIP

Franklin township lies east of Muddycreek. The rock strata which form the basis of its soils extend from the lower formations of the barren measures down close to the outcrop of the ferriferous limestone, and with the exception of the bottom lands of which the area is much smaller and that the barren strata cover a larger area the soils are very similar to those of Muddycreek.

CENTER TOWNSHIP

Center township lies east of Franklin and north of Butler townships. The Buffalo sandstone, which is so massive in so many of the townships of southern Butler county, is here a sandy shale more easily disintegrated and, therefore, produces soils that are not as stony and rough but not any more fertile than the more stony or rough soils of southern Butler.

The hillside soils of the township are derived from the strata comprised in what is known as the Freeport group from which the limy shales and limestone formations are absent, therefore, less fertile soils are formed. The valleys, while some of them contain productive soils, partake of the character of the strata on the hills and hillsides, from which they are largely derived. Some of the more rolling of these soils are clay and with careful farming will produce pasture grasses and corn and wheat but especially oats among the cereals.

OAKLAND TOWNSHIP

Oakland township lies east of Center and has the same soil construction.

DONEGAL TOWNSHIP

Donegal township lies east of Oakland on the Armstrong county line. The upland soils of this township are derived from the barren shales and some are fairly fertile. Here is a Divide between the waters of the Allegheny and Beaver rivers, and the streams flowing

into the Allegheny fall over narrow and precipitous slopes which makes the country hilly. The Freeport sandstone forms cliffs along both branches of Buffalo Creek, and in some places, covers the surface with rocks of considerable size. At Millerstown, in the northwestern corner and along the northern part, the land is rolling formed of the productive coal measure strata and fairly fertile.

FAIRVIEW TOWNSHIP

Fairview township lies north of Donegal along the Armstrong county line. The rock strata which form the basis of the soil of this township extend from the Mahoning sandstone down to the ferriferous limestone which appears in the northern section. The soils of this township are naturally fairly fertile, being derived from the more easily disintegrated coal shales from which the coal and lime are largely absent. These lands are poorly farmed because this is the center of a rich oil district and farmers receive a sufficient revenue from oil wells and become indifferent to farming operations. The land is mostly moderately rolling, easily farmed, with loamy soils some stony but not too stony for successful farming.

CONCORD AND CLAY TOWNSHIPS

The former lies west of Fairview and the latter west of the former. The soil formations of the two townships are so similar that they can be described together. In Concord township is located the center of the drainage system of northern Butler county. The soils are derived from the strata of the Freeport group with a small section of the barren rock on the highlands in the southern part of the township and some Mahoning sandstone further north which is usually shaly and disintegrates readily but does not form fertile soils. The Freeport sandstone is also shaly and easily disintegrated and forms better soils than the Mahoning. The northern part of the township north of Middletown is moderately rolling with loamy and sandy soils of fair fertility.

Clay township has a highland section forming the Divide between Slippery Rock and Muddycreek which makes some hilly country but not too hilly for successful farming. The Mahoning sandstone remains in some of these highlands and forms a sandy soil of poor quality the effects of which are noticeable along the hillsides. The Freeport group forms the remaining soils of the southern section which are similar to those of Clay township.

Near West Sunbury, the Freeport upper limestone occurs, but it is of such poor quality that when burned it does not slake. It seems that an effort should be made to crush this limestone finely and apply it to these sandy soils as ground limestone, perhaps good

results could be obtained. From West Sunbury eastward and westward the land is rolling, and the soils derived from the limy shales which occur here and the sandstones make a fairly fertile soil, easily farmed, and with good farming and the application of manure and organic matter such as the plowing down of heavy sods will furnish these soils can be made very productive.

BRADY TOWNSHIP.

In southern Brady township the high divide containing the Mahoning sandstone, referred to in Clay township, continues and forms hilly country much of which does not contain soils that pay well to farm. The slope of the hills are formed of the strata of the Freeport group of rock and while more fertile than the Mahoning are deficient in lime and do not produce well unless limed, well farmed and manured.

Northern Brady is moderately rolling. The soil is derived from the lower strata of the coal measures which are less sandy with more limy shales and with the ferriferous limestone outcropping along Slippery Rock Creek and here entering into the formation of the soil, with the most salient effects. This same moderately rolling country with soils derived from the strata of the lower coal measures and the ferriferous limestone follows Slippery Rock Creek and covers the whole of northern and central Worth township with soils of splendid fertility, adapted to the raising of all agricultural crops that thrive in this section of the State. Large acreages of sandy and sandy loam soils occur in this section especially adapted for early market gardening crops and should be used for this purpose while the more clayey soils should be used for raising the cereals such as corn, oats and wheat and the hay grasses. The limy shales of this formation are especially adapted to raising wheat, and the clovers and it seems should be used for this purpose. Muddycreek Valley contains soils of similar formation but the slopes are not as moderately rolling and the formations not as extensive.

SLIPPERY ROCK TOWNSHIP

Slippery Rock lies north of Brady and Worth and on the Mercer and Lawrence county lines on the west. The rock strata which form the basis of the soils in this township begin with the Freeport lower sandstone and extend down to the Homewood sandstone which outcrops in the streams but does not take part in the formation of the soils.

The Lower Freeport sandstone, as already indicated, remains in the highest elevations in this township, but instead of being a hard sandy rock, it is a soft shaly rock, easily disintegrated and, therefore, makes a gently rolling formation, easily farmed and adapted to

raising the agricultural crops. The best and most productive and always sure soils in this section are derived from the strata immediately overlying or associated with the ferriferous limestone. Here are some of the best corn, wheat, oat and clover soils in the State and when farmed well and with careful seed selection will produce a hard red wheat of superior type. In many places glacial deposits remain on these more elevated soils but these have become impregnated with the underlying formations, and their productive capacity is very similar. The bottom land in this township are very similar to those of the township, to the south already discussed. The ferriferous limestone outcrops in many sections of this township and is available for all purpose for which lime is used. It is pure.

CHERRY TOWNSHIP

Cherry township lies east of Slippery Rock. The rock strata from which the soils of this township are derived range from the Upper Freeport sandstone down to the Homewood sand in the streams. The country is more hilly than in Slippery Rock, with steeper slopes and sharper ridges such as occurs at the confluence of the two branches of Slippery Rock creeks in the eastern part of the township. The same type of bottom land already discussed is found along the two branches of these streams especially the northern branch. Glacial action is not as manifest along these streams as in Slippery Rock township. The ferriferous limestone outcrops at the juncture of the streams already referred to. Near Five Points it has been quarried for lime.

The soils throughout the northeastern and southeastern sections of the township are not as fertile as throughout the central part of the township but can by good farming be made productive.

WASHINGTON TOWNSHIP

Washington township lies east of Cherry and north of Concord. The elevations above tide in this township are among the highest in the county ranging from 1,500 to 1,575 feet. The land is hilly, with some fertile farming land on the ridges upon which the Upper Freeport limestone remains and has disintegrated and entered into the formation of the soil. Some bottom lands exist along the branches of Slippery Rock Creek in the northern and southern parts of the township. The ferriferous limestone outcrops in this township some distance east of Five Points near Cherry township.

The soils on many of the hillsides of this township are sandy, not very productive and wash easily, while those formed of the disintegrated shaly strata are more productive, do not wash readily and are better adapted for farming.

PARKER AND ALLEGHENY TOWNSHIPS

Parker and Allegheny townships occupy the northeastern corner of this county on the Armstrong county line. The rock strata from which the soils of these two townships are derived range from the Freeport upper sandstone down to the Homewood sandstone. The country is hilly and farming is difficult, but some of the soils are fairly fertile especially on the rolling lands where the soil does not wash. The ferriferous limestone outcrops in many places in both these townships, is easily accessible, of good quality soil with coal in close proximity to burn into lime ready to be applied to these soils so much in need of it. As already stated, the uplands of these townships are fertile. This is true of such places as Six Corners, southwest of Emlenton, where the soils are derived from the strata of the lower coal measures.

VENANGO TOWNSHIP

Venango township lies west of Allegheny. The rock strata which form the basis of the soils in this township range from the ferriferous limestone up to the Freeport upper sandstone, which occurs only in the higher hills. This stone is not sandy but rather shaly and is not very prominent but makes stony soils. The remaining strata all of the coal measures are rather shaly and form soils fairly fertile though hilly and for this reason difficult to farm.

MARION TOWNSHIP

Marion township lies west of Venango and has soils derived from the same rock strata as Venango except that the soils of the high lands of this township are formed of the more limy strata of the lower coal measures, and seem more fertile. Blue grass is growing along the roadside especially on these higher elevations. White oak timber prevails.

The ferriferous limestone outcrops on the road from Murrinsville south and enters into the formation of the soil producing soils of splendid fertility. This stone can be quarried here and burned into lime with the coal close by. The soils of this township are easily kept in productive condition by liming, the application of manures and good cultivation. Potatoes should do well here in many places; so should wheat because of the natural supply of lime in the underlying strata. The ferriferous limestone outcrops in many places besides those above referred to.

MERCER TOWNSHIP

Mercer township occupies the northwestern corner of this county. The Homewood sandstone is the lowest rock strata exposed and the

Lower Freeport sandstone the highest. The soils are therefore derived from the lower coal measures and from the Lower Freeport sandstone.

The soils of this township are made to a certain extent by glacial action and from glacial deposits together with the underlying rock. The land is rolling and much of it fertile, partaking of the character of the soils of Slippery Rock south of this township. The ferriferous limestone has been quarried south of Hornsville as well as along the Pittsburg Pike (not much of a pike now) near the western border of the township. Some of the land along this western border is swampy and should be underdrained in many places.

In some places deep tillage machinery will do the same thing as underdraining. The sections of lowland here referred to will, with deep tillage or underdraining, make the richest farming soils in this vicinity. The elevations above tide in this county vary from 1,190 feet at Hornsvllle to 1,575 in Washington township in the northern section. Animal husbandry should be the agricultural industry in this county.

LAWRENCE COUNTY

Lawrence county was erected out of portions of Beaver and Mercer by an Act of Assembly, March 20, 1849 and was named after Captain James Lawrence, U. S. N. It contains 230,400 acres, of which 193,762 acres is land in farms, and of which 148,487 acres is improved farm land. 16,032 acres were planted with corn in 1909, yielding 508,120 bushels; 16,158 acres were sown with oats, yielding 434,871 bushels; 12,099 acres were sown with wheat, yielding 195,122 bushels; 1,397 acres were sown with buckwheat, yielding 17,496 bushels; 916 acres were sown with rye, yielding 10,442 bushels; 2,811 acres were planted with potatoes, yielding 221,918 bushels; 18 acres were planted with tobacco, yielding 3,000 pounds; 36,403 acres were sown with all forage crops, yielding 44,574 tons of the various kinds of hay. Of the 148,487 acres of improved farm land, 85,834 were used in raising farm crops while 62,653 were not so used and were likely producing weeds. At this time Lawrence county had a population of 70,032 to feed, 18,055 cattle, 7,561 horses, 203 mules, 13,225 swine and 18,927 sheep.

Lawrence county lies west of Butler on the Ohio State line. The geological strata which, according to the Second Geological Survey of Pennsylvania, together with the glacial drift form the basis of the soils of this county, begin with the Sharon shales and

end with the Upper Freeport coal formation and the barren coal measures. According to the recent U. S. Geological Survey, the whole county, with the exception of a few small sections in the southern part, is in the Allegheny formation.

The Shenango River, flowing into the Lawrence from Mercer county, joins the Neshannock River flowing from the northeast at New Castle. About two miles further south these united rivers are joined by the Mahoning River flowing into Pennsylvania from Ohio and they form the Beaver River. These rivers, together with Slippery Rock Creek on the eastern side of the county which joins the Connoquenessing Creek, make the drainage system of the county.

PERRY TOWNSHIP

Perry township occupies the southeastern corner of the county. The strata from which the soils of this township are derived range from the Buffalo sandstone down to the base of the Upper Connoquenessing sandstone of the conglomerate strata. This latter does not take part in the formation of the soil. The Buffalo sandstone caps the highest hilltops of this section with enormous blocks. It also forms the magnificent gorge through which flows the Slippery Rock Creek.

The soils of this township are usually rough and poor except where the softer shales occupy the surface and the soil is formed of these. The soil suited for farming, are derived from these shales. The glacial drift and glacial action did not attain the importance in the formation of the soil in this township as it does elsewhere in this county.

SLIPPERY ROCK TOWNSHIP

Slippery Rock township lies north of Perry on the Butler county line. The strata which form the basis of the soil of this township range from the Darlington coal seam down beneath the Lower Mercer limestone in the conglomerate formation.

The southern part of Slippery Rock is hilly. The streams here cut narrow gorges with nearly perpendicular sides through the massive rock making wild and picturesque scenery at such places as Hells Hollow and along the Slippery Rock Creek. At Muddy Creek Falls, Kennedys Mills and the Bridge and throughout these vicinities on the uplands, the soil is usually fertile, being derived from the limy shales and limestone and soft easily disintegrated sandy shales. The land in this southeastern section is usually hilly and where the soils are formed of the sandy strata, stony, but productive. In the vicinity of Princeton in the central part of the township, the land is moderately rolling. The soil is formed of the strata overlying the Darlington coal vein, which are a shaly sandstone and limy admix-

ture and make a soil adapted for wheat and potatoes and clovers. Deep plowing and thorough cultivation with the application of manure will in a short time double the production of these soils.

At Rose Point, in the eastern part of the township, the ferriferous limestone occurs in a deposit from 15 to 20 feet thick and is quarried extensively. This stone makes a good clean lime well adapted for agricultural purposes. This same limestone outcrops north and south along Slippery Rock Creek in many places where it can usually be easily quarried. The soils of the northern part of this township are partly glacial and partly formed from the underlying rock. The glacier has planed down the hills and filled the valley so that in the valleys are soils of drift and the ground up rock from the hills, while the soils on the hills are largely derived from the underlying rock.

Both these formation produce fertile soils because the drift material contains limestone and limy shales, while the underlying rock strata contain the shaly and limy strata on the horizon of the ferriferous limestone. The ferriferous limestone also occurs in the northwestern part of this township and has been burned with the coal close by. Lime certainly can be made cheap here. These soils are adapted for raising all agricultural crops.

SCOTT TOWNSHIP

Scott township lies north of Slippery Rock on the Butler county line. The rock strata entering the formation of the soil range between the Darlington and Clarion coal veins. The Slippery Rock Creek, which flows through the southeastern part of this township, is no longer confined to a narrow gorge hemmed in by lofty hills but these are replaced by broad and moderately sloping plains with fertile soils. The underlying strata are softer and yield more readily to the agencies of disintegration. The great northern glacier planed down the surface and deposited drift material over the whole of this section to a considerable depth, so that the soils are a combination of drift materials and underlying rock wherever these come sufficiently close to the surface. Near Horlinsburg the ferriferous limestone outcrops and enters the formation of the soil. The vein is more than 12 feet thick easily quarried and makes a clean lime. From Horlinsburg northward the limestone outcrops in a number of places and its influence on the soil is every where evident. The land throughout the northern and northeastern section is fertile, moderately rolling easily farmed and adapted to all agricultural crops especially the grasses. The land in the western part is equally fertile, and of similar origin.

WAYNE TOWNSHIP

Wayne township lies west of Perry on the Beaver county line, with Slippery Rock Creek forming its eastern and Big Beaver Creek its western boundary. The rock strata which form the basis of the soils of this township range from the Brush Creek coal immediately underlying the Buffalo sandstone down to where the Sharon coal should occur making an interval of more than 600 feet of rock strata between the two. This is a hilly township. The streams except those forming the boundary lines and the Connoquenessing in the southern part of the township are small and make rapid descents from the highlands in the north into the streams to the east, south and west. The ferriferous limestone extends over well nigh the whole of this township with a vein varying in thickness from 15 to 25 feet accompanied with coal usually so close to it that the stone can be burned into lime at a low cost. The upland soils between the streams already referred to are fertile but in many places stony and not easily accessible. Along the streams especially the Big Beaver and where the Connoquenessing joins it are some splendid soils formed of drift materials and from the strata of the surrounding hills. These soils are well adapted for market gardeneing and dairying and with market facilities and with the markets such as exist here should be used for this purpose.

BIG BEAVER TOWNSHIP

This township lies west of Wayne on the Beaver county line, and has the Big Beaver Creek for its eastern boundary. The strata outcropping extend from the Upper Freeport coal down into the conglomerate, with an interval of 600 feet between the coal and the conglomerate. The Tionesta sandstone, the upper member of the conglomerate, usually thin and shaly changes into a massive sandstone along the Beaver River, beginning in the vicinity of Wampum, and south to Clinton. Above this formation is a plain extending back as much as a mile from the cliffs formed by this sandstone, which, according to the ideas of geologists, was at one time the bed of the Beaver River, but from which it changed its course to a section of the rock more yielding to the action of the water.

The ferriferous limestone crop out over this whole section along the river as well as over the northern part of the township and attains a thickness of from 15 to 25 feet. The Darlington coal vein which is extremely well developed in this township is located above this limestone and in many places sufficiently close to the stone that with little expense the limestone can be burned into lime with little handling. At Wampum along the river the land is rolling and fertile, and will produce a blue grass sod of the best type.

The soil along this stream northwestward is equally fertile. The following analyses represent the composition of the limestone outcrops in one place:

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	No. 1 Top	No. 2 Middle	No. 3 Bottom
Silica,	4.50	4.14	2.31
Sulphur,	0.06	0.20	0.17
Alumina,	0.20	0.21	0.24
Phosphoric acid,	0.07	....	0.04
Sesqueoxide of iron,	0.26	1.20	0.22
Lime,	49.31	50.16	54.04
Magnesia,	0.75	0.42	0.43
Carbonic acid,	40.54	39.87	41.72
Water and organic matter,	2.59	2.03	1.65

The limestone in this township is used at this time for the manufacture of cement. The central part of this township in all probability reaches the vicinity of the Mahoning sandstone, because bowlders of this stone occur here and make a rough country. Here it seems the fruit soils of the township should be found. The western section slopes downward to Little Beaver township with more moderately rolling formations, while the northern part in the vicinity of New Port and westward from there the country is also rolling, contains soil extremely well adapted for dairying.

SHENANGO TOWNSHIP

Shenango township lies north of Wayne and west of Slippery Rock. The rock strata entering the formation of the soils range from the shales above the Darlington coal vein down through the Tionesta sandstone. The hills along the streams in this township are usually steep, some of them precipitous, as where the ferriferous limestone occurs along Snake Run. This limestone extends over the entire township except where the streams have cut down beneath it and have completely carried it away. The vein is from ten to twenty feet thick and in many sections of the township its salient effects on the fertility of the soil are well demonstrated. Above the hill- and the streams the land is, some gently rolling and some nearly level, formed from the softer shales in the vicinity of the Darlington coal vein and making clayey and loamy, and some few sandy soils, all of fair fertility especially where the limy formations enter into the composition of the soils. Along Big Run in the northern part of the township the glacial drift has covered the country and entered into the formation of the soil with good effects. The remaining townships have largely glacial soils.

PLAINGROVE TOWNSHIP

This township occupies the northeastern corner of this county. The township is deeply covered with drift and its soils "the Volusia" of the national soil survey are fertile because here as elsewhere in this county as well as some of the surrounding counties limestone, granitic and gneissic material is distributed throughout the drift the disintegration of which forms soils containing the elements of, fertility.

On Taylors Run in the southern part of the township the ferriferous limestone outcrop and make a splendid exposure for quarrying the stone. It makes an excellent lime for agriculture and all other purposes for which lime is used. This same limestone also occurs in a similar way on Jamisons Run in the southeastern section of the township. At Plaingrove in the southern part of the township some of the strata underlying the soil enter into its formation and their effects are evident. The whole of the township is rolling, easily farmed and produces well all agriculture crops. It is above all a dairy section with blue grass pasture and a soil capable of producing large crops for the dairy.

WASHINGTON TOWNSHIP

Lies west of Plaingrove on the Mercer county line. All of this township, except where the highland extend above it is covered with drift material. The Darlington coal strata occur in all of these elevations and combine with the drift materials in the formation of the soil. Where this is not the case the soils are entirely derived from drift and are termed the Volusia soils of the U. S. Survey. The ferriferous limestone underlies all of the southern and eastern parts of this township, but does not usually enter extensively into the formation of the soil in this section.

This same limestone outcrops in the western part of the township; along Taylor Run, and has been quarried here and burned into lime during many years. In some places the Darlington and Kittanning coal veins are sufficiently close to the limestone to bring the two together with little cost. Black Swamp is located in the northeastern part of this township. It covers about two square miles. Here are large acreages of land adapted for trucking and more should be used for this purpose and could be used if underdrained. In the vicinity of Volant in the northwestern corner of this township the soil is of glacial origin and produces well all agricultural crops.

WILMINGTON TOWNSHIP

Wilmington township lies west of Washington along the Mercer county line. Well nigh all of the township is so deeply buried with drift that no other formations enter into the structure of the soil

except on the hilltops. On the hills in the vicinity of New Wilmington a sandy strata ground down by glacial action enters into the formation of the soil with rather injurious effects. These sandy shales are more sandy than shaly and make sandy soil apparently deficient in lime while further southwestward they become more limy and produce more fertile soils. Westward from New Wilmington the Lower Mercer limestone occurs. It is of such purity that it at one time was used as a flux in the furnaces and will, therefore, make a pure lime. The Lower Mercer coal vein also outcrop here and is so close to the limestone that it is said that in some places the two can be mixed together and the pit or kiln burned in the vicinity of the mine with little handling. At Wilmington Junction the land is low and needs underdraining. Above the Gorge along the Little Neshannock in the vicinity of Neshannock Falls, the land is rolling and fertile produces well all the agricultural crops. It is entirely of glacial origin. The northwestern section of this township is entirely covered with drift and the soils are formed of this material. In the northeastern section the strata of the Darlington coal formation remain and these in the higher elevations enter into the structure of the soils which, when limy, have a very desirable effect but when sandy a rather detrimental one. The ridges upon which the sandy formations occur are well adapted for raising apples. This is true of all sections of this county.

PULASKI TOWNSHIP

Pulaski township occupies the northwestern corner of this county with the Ohio State line for its western and the Mercer county line for its northern boundary.

This township, like Wilmington, is covered with drift material, that nowhere except on the hilltops do the underlying strata enter into the structure of the soil. The highest strata outcropping in this township are below the ferriferous limestone and therefore it does not have the benefit of this stone so plentiful elsewhere in the county. The Tionesta sandstone is geologically the highest strata that has been recognized. With such conditions prevailing it is a blessing for the farmer that the glacial drift covered up a formation the conglomerate usually deficient in the elements of plant food, with richer materials.

The land is rolling and usually easily farmed. This soil is adapted to raising the grasses especially along the streams. The more sandy and loamy uplands especially in the vicinity of the Lower Mercer limestone strata which occur south of New Bedford, the soils will produce splendid crops of potatoes and wheat and should be used for raising these crops.

Along the Shenango River which flows through the eastern part of the township the land is usually very moderately rolling and fertile adapted to dairy farming and some to market gardening. In the northern part of the township, some ridges of sandstone and sandy shales outcrop but they are usually so mixed with drift materials that the baneful effects of the sand are not so manifest. Some of the best apple soils of the county are located on the ridges of this township.

Hickory, Neshannock, Union and Mahoning townships have very similar soil formations and therefore can be discussed together.

MAHONING TOWNSHIP

Mahoning township lies south of Pulaski along the Ohio State line. The rock strata exposed in this township extend from about 80 feet above the ferriferous limestone down below the Sharon coal. The intervening strata are more sandy than shaly. The ferriferous limestone outcrops south of the valley of the Mahoning River and has been and still is being quarried here extensively for lime and other purposes. The shales on top of the limestone together with the drift still remaining on the hills south of the limestone outcrop, make fertile soils which should be well adapted for potatoes, wheat and clover and the higher and more sandy for raising apples.

Along the Mahoning River at Edinburg and Seymore, the valley is fertile and easily farmed and the soils adapted to growing the grasses. Further westward the valley becomes narrower and the hillsides steeper. Over these hillsides the Quakertown Run makes what is known as "Quaker Town Falls" a plunge of fifty feet and more. Quakertown Run rises in the Highlands on the top of which the ferriferous limestone is located and forms the basis of the soils which are hilly but fertile and productive, and should be used for raising the limeloving crops such as wheat, clovers and potatoes. Further north on the west side of Coffee Run near the northern limit of this township, is another such isolated remanent of the ferriferous limestone, north of which it does not occur. The country is hilly but the soil usually fertile and adapted for raising the crops already referred to. Between Coffee Run and Welsh Run, to the east is another ridge of ferriferous limestone which here enters the formation of the soils and produces good effects. Eastward from this section the town is less hilly and covered with glacial debris containing limestone, granitic and gneissic bowlders which enter into the formation of the soil with good effects. At Harbour Bridge the land is fertile and not as hilly because the sandy strata of the conglomerate enter the formation of the soil.

NESHANNOCK TOWNSHIP

Neshannock township lies between the Neshannock and the Shenango rivers, extending from the New Wilmington township line on the north to the junction of thes two streams on the south. The rock strata extend from the Darlington coal down to sixty feet below the conglomerate formation. Between the two streams above referred to through the central part of the township on an elevated plateau occur the Darlington coal strata and the ferriferous limestone. From this plateau the drift material has largely been removed and the underlying strata enter into the formation of the soil and where the limy shales and easily disintegrated shales prevail the soils are fairly fertile but where the sandstone and sandy shales prevail the soils are not so fertile. Here in the sandy formation are some of the apple soils of the county. The northern part of the township is more moderately rolling and the soil equally fertile. The soil along the streams is entirely of glacial origin and formed of similar material as that of other sections. The ferriferous limestone outcrops above the cliffs of the Tionesta sandstone along the Neshannock. This stone has been quarried and burned for lime for a long time. Further south at New Castle the county seat of this county the land is more gently rolling the soils fertile and adapted to the raising of all agricultural crops. The land east of New Castle above the terrace on which the town is located is all of glacial origin and is fertile producing well, all agricultural crops.

HICKORY TOWNSHIP

Hickory township lies east of Shenango and south of Wilmington and has the Neshannock River for its western boundary. The Darlington coal strata are the highest in this township, but do not enter the formation of the soil because everything is drift covered. The ferriferous limestone outcrops along the southern part of the township and forms a definite cliff along some of the hillsides. The land here is more hilly than along the streams but not too hilly for all farming operations to be successfully carried on. Some distance east of the Union township line on a hill the ferriferous limestone outcrops having a vein approximately 12-15 feet in thickness. It has been quarried here for a long time.

The following analysis gives the composition of this stone:

22 Page 48.

Carbonate of line,	94.78%
Carbonate of magnesia,	1.39%
Oxide of iron & alumina,	1.18%
Sulphur,	.12%

Phosphorus,	.03%
Insoluble residue,	2.08%
	99.58%

This limestone occurs along Hettenbaughs Run near the central part of the township and from there eastward and northward east of the Neshannock River where it has been quarried in many places. The uplands throughout this section are fertile and well adapted for raising the agricultural crops. The Tionesta sandstone forms cliffs along the river in a number of places in this township but the valley is usually of considerable width and the soil made of glacial drift of the same material already referred to.

UNION TOWNSHIP

Union township lies between the Shenango and the Mahoning rivers and comes to a point at Mahoningtown where the two rivers join to form the Beaver River. At Mahoningtown the soils are gently rolling and fertile, made entirely of glacial drift, well adapted to market gardening or trucking or for dairying. The land along the streams has already been referred to. The central part of this township is a high ridge upon which the strata of rock below the Darlington coal vein occur, covered up with drift materials. The ferriferous limestone was not seen here in its usual place.

TAYLOR AND NORTH BEAVER TOWNSHIPS

Taylor township lies west of Shenango township and has the Beaver and the Shenango rivers for its western boundary. This township, with the exception of the eastern part, is an alluvial plain on which the soils are entirely derived from the alluvium of the river and the glacial deposits. These deposits form terraces, the lowest one in many places more than a mile wide, forms the richest soil especially adapted to the most intensive farming. The second of these terraces is about 60-80 feet higher and from it a sloping plain rises to the third one about 160 feet above the river. The soils on these slopes and terraces are fertile and well adapted for the raising of all agricultural crops. As already indicated, along the eastern section are some highlands in which the ferriferous limestone remains and to some extent enters the formation of the soil.

The following analysis represents the composition of this stone:

22 Page 48.

Carbonate of lime,	93.34%
Carbonate of magnesia,	1.46%
Oxide of iron and alumina,	1.56%
Sulphur,	0.12%
Phosphorus,	0.04%
Insoluble residue,	3.07%

Along Hog Hollow Run, flowing in from Shenango township, the southern extension of this limestone occurs.

NORTH BEAVER TOWNSHIP

North Beaver township lies directly west of Taylor township and extends from the Beaver river westward to the Ohio State line. The strata exposed, few of which enter the formation of the soil, range from the lower conglomerate rock to the Lower Freeport coal. The township, except where removed by erosion, is covered with glacial drift and sand on the highest elevations to a depth of from 30-60 feet and therefore the soils are about all glacial.

Along the Mahoning and the Beaver rivers the valley is fertile and especially adapted to dairy crops such as thrive here. Where Hickory Creek, which rises in the northwestern part of this township, flows into the Beaver river is a wide plain of splendid fertility adapted to intensive farming of the highest type. The valley narrows further south but remains fertile. Mt. Jackson, north of Hickory Run, is the highest elevation in the township and is about 400 feet above the Mahoning River.

Along this mountain the drift material is more than 40 feet deep. In this part of Hickory Run are some steep bluffs; but in going northwestward along the run these steep sides become moderate slopes because the valleys are filled and everything is buried under glacial debris. Still further north the ferriferous limestone is reached. The vein is about 15 feet thick easily quarried and makes a very pure agricultural lime as the following analyses of a sample of the stone shows:

22 Page 130.

Carbonate of lime,	95.76%
Carbonate of magnesia,	1.09%
Oxide of iron and alumina,	9.63%
Sulphur,	0.08%
Phosphorus,	0.01%
Insoluble residue,	1.97%
	99.54%

The limestone underlies this whole section and in some places has been scoured by the glacier so that the soils remaining are partly of limestone origin. The northern part of this township, though covered with glacial debris, is underlaid with easily disintegrated shales, and gently rolling plains of splendid fertility are formed.

The southern section of the township has soils formed of glacial drift largely which are similar to those of the northern part, except that in the southwestern part the ferriferous limestone does not come to the surface. This township is one of the best farming districts in the county and contains many splendid farms, especially adapted to the dairy industry.

LITTLE BEAVER TOWNSHIP

Little Beaver township occupies the southwestern corner of this county and lies directly south of North Beaver. The rock strata which outcrop in the township range from the Upper Freeport coal down to within 20 feet of the ferriferous limestone. The intervening strata are shaly or shaly sandstone formations.

Wherever they enter the formation of the soil, which they do in connection with the glacial drift, which covers all of this township except some of the hillsides and hilltops from which it has been washed away, the shales make a more clayey soil while the shaly sands make a more sandy soil. The former is better adapted to raising the grasses such as timothy, while the latter is better adapted to potatoes and the cereals such as wheat and rye and corn.

The valleys of the township are filled with glacial drift and the soils are entirely of this origin. The hills have been rounded and planed down by the glaciers, making farming more easy than in Big Beaver township where they are steep. At Enon Valley the land is moderately rolling, fertile and easily farmed. Along the Little Beaver River, in this section, are soils especially adapted to the dairy industry because they will produce large crops of roughage and good blue grass pasture of a superior type. The largest amount of human nutrition could be produced in this county through the dairy industry because the cow can convert into human food a very large percentage of the crops that can readily be raised on these soils which are not available for the use of man until manufactured by the animal.

BEAVER COUNTY

Beaver county was organized from parts of Allegheny and Washington counties by Act of the Assembly, March 12, 1800. It contains 274,500 acres, of which 229,788 acres is land in farms, and of

which 173,426 acres is improved farm land. 14,540 acres were planted with corn in 1909, yielding 454,654 bushels; 14,810 acres were sown with oats, yielding 376,141 bushels; 11,489 acres with wheat, yielding 167,175 bushels; 226 acres with buckwheat, yielding 2,411 bushels; 486 acres with rye, yielding 5,210 bushels; 2,770 acres were planted with potatoes, yielding 219,822 bushels; 31,787 acres sown with all forage crops, yielding 38,209 tons of the various kinds of hay. Of the 173,426 acres of improved farm land, 78,033 were used for raising farm crops while 95,493 were not so used and were likely producing weeds. At this time Beaver county had a population of 78,353 people to feed, 16,067 cattle, 6,734 horses, 121 mules, 9,857 swine and 18,930 sheep.

SOIL FORMATION

Beaver county lies south of Lawrence, west of Butler and Allegheny, north of Washington, on the Ohio State line. The geological strata from which the soils of this county are derived range from the Beaver River group, through the Clarion coal group, the Kittanning, the Freeport, the Upper Freeport coal group, the lower barren coal measures up into the Pittsburg coal horizon. In other counties these groups are classified under the conglomerates, the lower productive coal measures, the lower barren coal series and the upper productive coal measures. The United States Geological Survey places the county into the Conemaugh and Allegheny formations.

The county is drained in the southern part by the Ohio River and its smaller tributaries and in the northern part by the Beaver River and its tributaries, all of which flows into the Ohio at Beaver, the county seat of the county. The western part is drained by smaller tributaries of the Ohio flowing south and by little Beaver River flowing along the western border of this county in the State of Ohio. The northeastern section is drained by the Connoquenessing Creek which flows across the northeastern corner of the county into Lawrence county and into the Beaver on the border of Lawrence and Beaver.

ECONOMY AND NEW SEWICKLEY TOWNSHIPS

Economy township occupies the southeastern corner of the county east of the Ohio River. The strata from which the soils of this township are derived, range from the Freeport coal group to within 100 feet of the Pittsburg coal seam; the soil therefore is formed of the barren measures. At the mouth of the Big Sewickley Creek and thence northward is a beautiful terrace upon which is some of the most fertile soil in this district. The towns along the river, such as Economy are built on this terrace. In the southern part of this township both the Pine Creek and the Brush Creek limestones out-

crop and enter into the formation of the soil, and wherever this happens, the land is productive. These veins of stone, if they are not sufficiently pure to burn into lime, it is evident from the effects on the soil, into the formation of which they enter, that if they were finely crushed and applied in this form, to these soils, most of which are wonderfully deficient in lime, the effects would be all that could be desired. Near Wall Rose in the eastern part of the township the crinoidal and the Pine Creek limestone outcrop in several hills. The crinoidal is seen lying about the fields. The vein is thin but persists from this section northward. Below this limestone the red clay, referred to in the discussions of Allegheny and Butler counties, forms the soil and in many places is so tough when it is wet and so hard when dry that it is possible only under just exactly the right conditions, to do anything with it in the way of cultivation. A heavy application of crushed limestone or coal ashes would put this soil in condition to be cultivated and would make it productive. In the northeastern corner are some better soils derived from more easily disintegrated shales. Through the central part of the township the small Divide from which several small streams arise, forms a rolling section of land.

New Sewickley township lies north of Economy on the Butler county line. The strata from which the soils of this township are derived range—not including Big Knob in the center of the township—from below the crinoidal limestone, down to the Darlington coal seam along the northern part of the township. The soils of this township are very similar to those of Economy township, except that the lower strata of the lower barren measures and the upper strata of the lower productive measures form the soil along a few of the streams. Big Knob is located in the central part of this township, the summit of which is formed of the Morgantown sandstone. From the top of this Knob the hilly country and the ravines of the streams can be seen in all directions. Along Crows Run in the southern part of the township, the Freeport limestone outcrops and has been quarried and the coal above it mined for burning the limestone below the coal. Further northeastward from this stream on the Divide between its tributaries and those of Brush Creek, near the eastern boundary of the township is rolling land of fair fertility. The northeastern corner has a similar formation.

DAUGHERTY TOWNSHIP

Daugherty township lies west of New Sewickley along the Big Beaver River. The strata outcropping in this township are the same as those of the previous township, except that the lower productive coal strata occupy a much larger area than in the previous township. The terraces along the river already referred to occur

here. New Brighton and other towns are built partly on the second and on the third terraces. These terraces also contain some farming soils, but the most extensive soil areas are located on the higher elevations, above the terraces. Some idea of the steepness of the hills above Beaver dam may be had from the 400 feet of fall of Trough Run within a distance of half a mile above its mouth. Along this part of the township the farming land is confined to the uplands and the soil is formed of the lower barren strata.

ROCHESTER TOWNSHIP

Rochester township is surrounded by Daugherty. It has the Beaver River for its western boundary and the Ohio for its southern. The lower productive coal measures form its soils, except those of the terraces. The town of Rochester is built on the second and third terraces already referred to which have a soil of peculiar fertility. The ferriferous limestone outcrops in this township, along several of the runs with a thickness of five feet, with sufficient coal close by to burn it for lime, where it is quarried. This will make it possible for farmers to get lime, which is so much needed, in many of these soils, at small cost.

NORTH SEWICKLEY TOWNSHIP

North Sewickley township lies directly north of Daugherty with the Big Beaver River for its western and the Lawrence county line for its northern boundary. This township has a varied series of soils, composed along the streams of terrace and drift materials and the conglomerates, with the lower coal measures, forming the soil along the hillsides and the barren coal strata forming the soils of the highlands. The farming land of this township is largely confined to the highlands, except in a few sections along the streams, these however are small because, as in the southern part of the township, in a ravine 347 feet of strata are exposed in one section. The same condition prevails along all the streams of the township and, therefore, highlands are the dominant formations. The Upper Freeport coal outcrops opposite Homewood, whence the name of the Homewood sandstone which attains a tremendous thickness here, at an elevation of 450 feet above the Beaver River. This highland which is about three miles east of the river, forms the divide between it and Brush Creek and the Connoquenessing, extends to the northern extremity of the township. The Mahoning sandstone caps this ridge, which is nothing to its credit. The Freeport limestone outcrops along the ridge, in a vein eight to ten feet thick, along the Connoquenessing in the eastern part of the township. The cliffs are equally as steep and precipitous as along the Beaver River and the smaller streams on the west side. In the northern part of this township

along this stream, the ferriferous limestone twenty-two feet thick outcrops and its detached parts lie along the bluff formed by it. The effects of this stone is noticed on the soil. Coal and limestone are sufficiently close together to burn the stone where it is quarried.

MARION AND FRANKLIN TOWNSHIPS

Marion and Franklin townships, both lie east of North Sewickley on the Butler county line, the latter occupying the northeastern corner of the county, while the former lies directly north of New Sewickley. The Connoquenessing Creek forms the northern boundary of the township. This stream before it enters Beaver county cuts down into the conglomerate and after flowing some distance, in this township, attains vertical clifts in many places 100 feet high. The smaller streams of the township rise on the highland already referred to in the discussion of New Sewickley township and flows rapidly down the steep descent into the Connoquenessing. Here the farming soils are again confined to the highland between the Connoquenessing and Brush Creek and to the eastern part of the township along the slopes of the creek. The same condition prevails in Franklin township, except that in the southeastern corner of the township, the land partakes of the fertility of the soils, formed of the lower productive coal measures, in the vicinity of Zelienople and Harmony in Butler county, for a description of which see Butler county. The whole of the eastern part of the township partakes of the soil, structure and fertility of Cranberry, Jackson and Lancaster townships of Butler county.

BIG BEAVER TOWNSHIP

Big Beaver township lies west of the Big Beaver river, on the Lawrence county line. The outcropping strata extends from the Brush Creek coal seam down into the conglomerates. On the southern border at Homewood the Homewood sandstone forms a high cliff as already stated. Above this formation, the land extends in a rolling upland, with soils derived from sandstone and shales, away from the river, to the Divide between the North Fork of Little Beaver flowing westward and the tributaries of Big Beaver flowing eastward. In the railroad cut at the summit, the limestone under the Brush Creek coal, the Freeport and the so called Butler limestone, outcrop. The Brush Creek with a thickness of five feet, the Lower Freeport with shales and clays interstratified with a total thickness of five feet, including two feet of shale. The Brush Creek limestone outcrops in a number of places along the roads in this section and enters the formation of the soil with the most salient effects. The vein one mile north of the summit is eight feet thick, still further north the same vein outcrops again

with a thickness of six feet; the stone does not seem pure but the good effects it exerts on the soil are evidences of what it would do, if applied in a finely ground condition. At New Galilee in the western part of the township, the land is moderately rolling the soil derived from the lower productive coal series of strata, is fairly fertile. Along Jordans Run which flows into the Little Beaver near this town the Freeport limestone occurs in a vein of four feet in thickness and is scattered about the hillsides where it outcrops beneath the Mahoning sandstone. This stone could be crushed and ground and applied to these soils with little cost. The Mahoning sandstone forms cliffs along the hills wherever it occurs and a rough country. Northward from New Galilee to the Lawrence county line the country with soils of the lower barren strata is rolling, with some fertile sections.

DARLINGTON TOWNSHIP

Darlington township lies west of Big Beaver and occupies the northwestern corner of the county, with the Ohio State line for its western boundary. The North Fork of Little Beaver River forms the southern boundary of township. Darlington, a town of some size, is located at the southwestern corner of the township. Along the hillside northwest of the town, which is capped by the Mahoning sandstone, the Freeport limestone occurs in a vein three feet thick, of sufficient purity to make lime for all agricultural purposes.

A coal seam, likely of sufficient purity for burning the lime, occurs a short distance below the limestone. This same formation extends well nigh throughout the southern section of the township and forms soils of good fertility. Northwest of Darlington, passing through the central part of the township, is a Divide from which the streams flow southward into the North Fork and upon which occurs the Mahoning sandstone and makes some rough sections. Above the Mahoning sandstone are some shales, which here form a soil, which, with liming and the application of manure, can be made fairly productive. Along the northern part of the township is a rolling section known as Enon Valley, extending into Lawrence county with a soil derived from the lower productive strata, easily farmed and which, with good agricultural practice, produces well all agricultural crops.

From the Lawrence county line southward the land gradually slopes up to the Divide, already referred to, from which the streams flow northward into the North Fork of the Little Beaver, flowing eastward, and from whence it swings round by Darlington and flows westward and drains this whole section. Glacial action to some extent became a leveling agent throughout this section rounding

the hills, filling the valleys and making the land more productive. This is a dairy section and the soil should be given up to this business.

SOUTH BEAVER TOWNSHIP

South Beaver township lies south of Darlington on the Ohio line. The strata which make the basis of the soil range from the barren measures through the lower productives into the conglomerates, along Brush Run and along North Fork. The soils along the North Fork are similar in formation to those of Darlington township already discussed. Between Brush Run and the North Fork, in the northern part of the township, the Mahoning sandstone covers the hills and the hillsides with massive blocks of stone making a country of little agricultural value. South of Brush Run, with hillsides equally as steep as those north of it, are some rolling uplands between the streams flowing north into Brush Run. These are the farming lands of this township.

Brady's Run rises in the eastern part of this township on the same highlands on which the streams flowing north, already referred to, rise and flows eastward into the Big Beaver. On this Divide of streams is a small farming section with some farming soil seemingly well adapted to raising apples. The Freeport limestone, both the upper and the lower, outcrop in many places throughout this township with coal so close by that the stone can be burned where it is quarried.

CHIPPEWA TOWNSHIP

Chippewa township lies east of South Beaver, with the Big Beaver River for its eastern boundary. The strata from which the soils are derived range from the lower barren measures through the lower productive into the conglomerates. The farming lands of this district are largely confined to the highlands. The hillsides along the numerous streams are so steep that it was difficult to make examinations. The Freeport limestone, both the upper and lower, occur along these hills as well as the Brush Creek, usually so close to coal seams that the stone can be burned where it is quarried. This land in so far as possible should be converted into pasture and hillside farming should be done, such as is recommended for a number of townships in Greene county.

PATTERSON TOWNSHIP

Patterson township occupies the strip of land between Brady's Run and the Big Beaver.

Beaver Falls is located in this township and is built on the second and third terraces along the river, on which are some farming soils of special adaptation—some for trucking and other for small fruit growing.

BRIGHTON TOWNSHIP

Brighton township lies south of Chippewa with the Beaver River for its eastern and the Ohio River for its southern boundary. Along the river from where Brady's Run flows into it south, the terrace on which the town of Beaver, the county seat of this county, is built, is broad and contains some splendid trucking soil a considerable acreage of which is used for this purpose.

In the vicinity of Beaver is a longer section along the river and is also more fertile. Above this terrace the hills become steep, too steep for farming, until the summit is reached upon which the hilly uplands which make the largest acreage are located. In the central part of this township is quite an area of such an upland on which are some fair farming lands.

At Vanport, along the Ohio River, the ferriferous limestone is eighteen feet thick. It has been quarried here for a long time and is still being quarried. The following analyses give the composition of the various strata:

	Top	Upper	Middle	Lower
Carbonate of lime, ..	88.464	93.482	91.607	91.089
Carbonate of magnesia, ...	1.445	1.544	1.566	1.587
Oxide of iron and alumina, ...	2.324	1.823	1.291	1.589
Sulphur, ...	0.097	0.030	0.290	0.040
Phosphorus, ...	0.029	0.047	0.030	0.047
Insoluble residue,..	7.030	2.770	4.780	4.800
	99.389	99.696	99.564	99.152

Along this part of the river are some fertile soils on which all agricultural crops will thrive.

INDUSTRY AND OHIO TOWNSHIPS

Both these townships lie west of Brighton, both having the Ohio River for their southern boundary, while Ohio has the Ohio State line for its western boundary and Industry is enclosed north and west by Ohio township. The strata from which the soil of these townships are derived begin above the Buffalo sandstone, likely the upper stratum of the Mahoning, and range down through the lower productives. The sandstone forms a cliff along the river broken by an occasional small area that could be farmed. Above the sandstone on the highland, from which Wolf Creek and Six Mile Run take their rise, are some farming soils made of the lower barren strata which produce crops of the hay grasses and would produce apples if the trees growing here now can be taken as evidence.

Passing on the terrace in the curve of the river from Industry into Ohio township, the rolling formation of fertile soil continues along the terrace to within a short distance of Dry Run where the river curves northward. The highland between Dry Run and Island Run or rather the land between Dry Run, the Little Beaver River and Island Run, in which the strata extend from about 90 feet above the Mahoning sandstone down into the lower strata of the lower productive measures on these highlands, some fertile soils occur because of the outcropping of the Pine Creek and the Brush Creek limestone veins of the lower barren coal measures. In the eastern and northern parts, upon the highland Divides, is some rolling land of fair fertility adapted to raising the pasture grasses such as blue grass. This land does not wash readily, will grow heavy sods, which by careful attention can be maintained for some time and which can be renewed by means of a rotation of crops, such as corn, potatoes and rye and timothy and clover, or corn, oats and timothy and clover. A rotation such as here outlined will apply in many sections of this county.

The townships of Beaver county south of the Ohio River have soils, with the exception of a few small areas, derived from the strata ranging from below the Pittburg coal bed to the top of the lower productive coal measures along some of the streams.

HANOVER TOWNSHIP

Hanover township occupies the southwestern corner of Beaver county, with the West Virginia line for its western and the Washington county line for its southern boundary. The strata from which its soils are derived range from about seventy-five feet above the Pittsburg coal seam down to about 100 feet above the Upper Freeport coal so that, with the exception of the small section of the Pittsburg coal series, all of the soil is formed of the lower barren strata.

In the southern part of the township, in the vicinity of Frankfort, the Pittsburg series of rocks, composed of a five foot vein of limestone beneath the coal with limy shales, shales and shaly limestone, both above and below it, form the soil.

It is evident from this that the soil in this vicinity is fertile, adapted to the growing of all farm crops. In the western part of the township the land is rolling with a soil formed of the upper strata of the lower barren series which contain several limestone veins, one of which outcrops on the surface along the road north of Frankfort; evidently not sufficiently thick or pure to make lime but small as it is, its effects on the productiveness of the soil are evident wherever it outcrops along the northern part of the township on

the Divide between the streams flowing south and southeast into Raccoon Creek and those flowing north into the Ohio River. On this Divide, which extends into Greene township to the north of Hanover township, is a large acreage of soils formed of shales, sandy shales, limestone, limy shales and slates beautifully rolling and fertile especially where the limy strata largely enter the formation of the soil. The crinoidal limestone outcrops in the eastern part of the township along Big and Little Travers creeks. Some of these streams flow through deep ravines, especially Big Travers Creek, Frankfort Springs, while the uplands is moderately rolling and fairly fertile.

GREENE TOWNSHIP

Greene township lies north of Hanover with the Ohio State line for its western and the Ohio River for its northern boundary. As already stated, the southern part of this township forms part of the Divide between the creeks, flowing south and east and those flowing north forming a nicely rolling upland.

Beginning a little south of Hookstown the land becomes more hilly and the further north toward the river the more hilly it becomes. The crinoidal limestone outcrops along a number of the hills, even those along the river near Georgetown, where its effects are noticeable in the forests. At Shippingport, on the south side of the river, on the hills south of this place the crinoidal limestone outcrops along many of the hills and enters into the formation of the soil, and makes a peculiarly fertile soil producing oak forests only equalled in Washington county and the eastern part of the State. Along these hills apple trees grow to an enormous size and produce well, from appearances at the time this examination was made.

RACCOON TOWNSHIP

Raccoon township lies east of Greene with the Ohio River for its northern boundary. The strata which form the basis of the soil in this township range from the Morgantown sandstone down to the ferriferous limestone. The Morgantown sandstone caps the hills along the southern part of the township and makes a stony soil. On the hills along Service Creek in the southern part of the township the crinoidal limestone crops out and enters into the formation of the soil, but the land is hilly and difficult to farm and little benefit agriculturally can be derived from the better soil existing here.

On the hills between Service Creek and the river is another formation of a similar character, but with less steep hills. The soil throughout this section is adapted to apple and peach raising.

INDEPENDENCE TOWNSHIP

Independence township lies south of Raccoon and east of Hanover, with the Allegheny county line for its southern boundary. The strata from which the soil of this township is derived are confined to the barren coal series from a little above the Morgantown sandstone down. This sandstone outcrops along Raccoon Creek as far northward as Service Creek where it caps the highest hills.

It makes some rough soil along the uplands of the streams. Below it occurs the crinoidal limestone which is seen in nearly all the hills in the township; and in many places is the stratum from which the soil are derived varying from two to four feet in thickness and sufficiently pure to make lime for agricultural purposes. The land away from the streams throughout this township is rolling and much of it, as already indicated, fertile, adapted to raising all general agricultural crops. Apples and peaches produce well throughout the larger part of this township. So do the small fruits. This is true of other townships throughout this section.

HOPEWELL TOWNSHIP

Hopewell township lies northeast of Independence, east of Raccoon, with the Ohio River for its eastern and Allegheny county for its southern boundary. The strata from which the soil of this township is derived range from the Pittsburgh coal seam, in the hills of the southern part of the township to below the Freeport coal.

The hills in which the Pittsburg coal occurs rise 600 feet above the Ohio River. The soil of the southern and central part of the township is formed of the strata above the crinoidal limestone. Above the river hills the land is rolling, and wherever the limy shales and shaly strata form the soil, it is fertile; while where the Morgantown sandstone outcrops, the land is rough and difficult to farm and not productive. The streams have cut deep gorges into the underlying strata in many places which makes a rough country along these water courses, with little farming land. Along the northern part of this township, the crinoidal limestone outcrops on a Divide which makes some rolling land in the formation of the soils of which the crinoidal limestone takes part.

MOON TOWNSHIP

This Divide or rolling upland extends into Moon township, but soon the crinoidal limestone rises into the hills and all the strata forming the soil are below the lower barren measures. Some of these uplands are rolling and fairly productive, but the soil is deficient in lime, and where this is not applied, followed with the plowing down of sods and the application of manure, returns from

these soils are meagre. Potatoes, small fruits, apples and peaches yield splendid returns here. The location of this and the surrounding counties puts them into a class by themselves.

If these counties, with the soils that they possess, were located at a distance from the markets, the proposition would be entirely different; but within the shadow of Pittsburgh and the surrounding cities and towns, every available acre of this land and the land of the surrounding counties should be used for raising agricultural, horticultural and animal products. The rolling land of Hanover and Greene townships, makes this a dairy section, while the hilly parts of these and the uplands of the townships upon which the Ames and the crinoidal limestone enter into the formation of the soil and where blue grass grows naturally and forms a permanent pasture and a splendid sod, makes such places stock raising sections while, where the limestone does not occur and where the soil is formed of shaly sandstone and sandstones, apples and peaches and small fruit will thrive, and where the shales alone make a clay soil, hay grasses and clovers can be made to thrive by the use of lime. Systems of farming to do all this will have to be developed.

ALLEGHENY COUNTY

Allegheny county was organized from parts of Westmoreland and Washington counties by Act of Assembly, September 24, 1788. Allegheny county contains 464,000 acres, of which 308,342 is land in farms, and of which 244,720 acres is improved farm land. 20,408 acres were planted with corn in 1909, yielding 643,008 bushels; 20,681 acres sown with oats, yielding 513,709 bushels; 13,252 acres with wheat, yielding 213,654 bushels; 359 acres with buckwheat, yielding 4,146 bushels; 2,090 acres with rye, yielding 25,784 bushels; 4,659 acres were planted with potatoes, yielding 330,519 bushels; 53,959 acres sown with forage crops, yielding 58,794 tons of the various kinds of hay. Of the 244,720 acres of improved farm land, only 115,408 acres were producing farm crops in 1909, leaving 129,312 acres of improved land not raising these crops. At this time Allegheny county had a population of 1,018,463 people to feed, 26,825 cattle, 11,199 horses, 160 mules, 13,620 swine and 6,544 sheep.

Pittsburg, the chief city of western Pennsylvania, is situated in this county. In this and the surrounding cities and town are located the largest iron industries in the world, affording the best market for all farm products.

The rock strata, from which the soils of this county are derived, range from the lower productive coal measures which outcrop in a few places in the part of the county north of the Ohio and Alle-

gheny rivers through the lower barren coal strata, which well nigh cover this northern section up through the upper productive into the upper barren measures and the Washington group of rocks the latter three of which cover the southern part of the county. According to the U. S. Geological Survey the northern and central part of the county are in the Conemaugh formation and the southern part in the Monongahela formation.

The drainage of the county is accomplished by the Allegheny River and its tributaries, flowing in from the northwest, the Monongahela and its tributaries flowing in from the south and the southeast, and the Ohio River, formed by the confluence of the above named two rivers and flowing westward through the county, and its tributaries. The northern townships, as already stated, is largely covered by the strata of the lower barren coal measures and, in many respects, are very similar to the southern townships of Butler county.

Fawn and East Deer townships occupy the northeastern part of the county. The rock strata, from which the soils are derived, extend from above the crinoidal limestone down to the Upper Freeport coal.

The northern part of Fawn, in the vicinity of Millertown, is a rolling country formed of the softer shales of the barren strata, deficient in lime. Along the river the land is hilly and much of it too steep for successful farming. Along the county road from Millertown to Tarentum a splendid illustration of the change from a moderately rolling country in the northern part of these townships to a very hilly country along the river, occurs.

WEST DEER CREEK TOWNSHIP

West Deer Creek township lies west of East Deer Creek and Fawn townships. The rock strata from which the soils are derived range from the Pittsburg coal in the southeastern corner of the township down to the Upper Freeport coal in the northeastern corner of the township. The township is hilly, but some of the uplands derived from the more easily disintegrated shales of the middle of the lower barren measures are fairly fertile. The crinoidal limestone, referred to in the discussion of southern Butler county, occurs in some of the hills with the underlying red shale clay soil so devoid of the physical condition for plant growth that little is produced, all of which can be remedied by a heavy application of crushed limestone, coal ashes or lime, and the introduction of organic matter.

INDIANA TOWNSHIP

Indiana township lies south of West Deer and west of East Deer townships. The Pittsburg coal remains in the highest elevations in the northeastern corner of the township and near Deer Creek a

little distance north of where it flows into the river. The Pittsburg limestone, which usually underlies this coal, occurs in these elevations and enters the formation of the soil, but its effects are not very evident.

The sandy and limy shales and the shaly strata of the measures between the Pittsburg coal and the Pine Creek limestone form the soils of this township which are fertile or comparatively poor in harmony with the underlying, or on the hillsides the overlying strata from which they are made. These soils can be successfully farmed and paying returns realized, with the markets so close by.

HAMPTON TOWNSHIP

Hampton township lies west of Indiana and north of Shaler. The rock strata in this township begin with the crinoidal limestone and extend down below the Freeport limestone along Pine Creek where the massive Buffalo sandstone forms the soil.

The barren measure rock form the soils which here are shaly and therefore deeper and more fertile than the sandy formations. The crinoidal limestone outcrops in several sections on the uplands above Pine Creek and enters the soil but is not very marked in its effects. Northeastern Hampton is the headland of a number of small streams and therefore some moderately rolling uplands exist here the more level of which need underdraining.

RICHLAND TOWNSHIP

Richland township lies west of West Deer on the Butler county line. The rock strata of this township are among the highest, geologically, in this section, beginning with the Morgantown sandstone so prominent along the Ohio River in Kilbuck township. In the northern part of this township this rock is massive and where the softer strata have been disintegrated or where the strata under it have been disintegrated large bowlders remain which have resisted all agencies of change.

Deer Creek, several branches of Pine Creek, Glade Creek and Breakneck Creek all make their beginning in this township which is, therefore, an upland of streams and is rolling, of fair fertility and formed of the barren strata exclusively, not all of which produce desirable farming soils in this section.

PINE TOWNSHIP

Pine township lies west of Richland on the Butler county line. The strata of this township begin with the Pittsburg coal bed in a knob in the southern part of the township and extend down below the crinoidal limestone.

All the soils, with the exception of those about the Knob, are derived from the barren strata. The land is hilly in some sections, but the greater part of the uplands are rolling and easily farmed and can be made productive by the use of lime and manure and such ingredients of commercial fertilizer as practical demonstrations will indicate are needed.

MARSHALL TOWNSHIP

Marshall township occupies the northwestern corner of this county. The soils of this township are derived from the barren coal measure shales which have been disintegrated so that the land has mostly become moderately rolling and fairly fertile. Along Brush Creek is a wide valley all eroted out of the barren shales covered with drift and alluvial deposits. This valley is fertile, adapted to market gardening crops, dairying or the raising of the regular agricultural crops, or for meadow lands; this latter is probably the best because the land can be kept up with less labor which seems to be abnormally hard to get here.

SEWICKLEY TOWNSHIP

This township occupies the western extremity of the county north of the Ohio River. The lower barren coal shales and sandstones are the only outcropping rocks in this township. The terraces referred to in the discussion of Moon township are different. In Moon township the second and third terrace are well nigh obliterated while in Sewickley the second forms a beautiful plain upon which the town of Sewickley is built. This terrace also contains a fertile soil but is largely occupied by villages and towns.

The soil in the central and northern part of the township are rolling especially on the Divide between Big and Little Sewickley creeks. Silty or clay loams are the predominant soils, adapted to raising the grasses such as timothy, and when these soils are acid red top will thrive. These soils need lime and organic matter to make them productive. The crinoidal limestone occurs here and under it the red shale, which forms a tough clay soil, which can be made productive by the addition of coal ashes or even sand.

MOON TOWNSHIP

Moon township lies south of the Ohio River along the Beaver county line. The rock strata outcropping in this township extend from above the Pittsburg coal vein to about 500 feet below these strata. A Divide, running approximately east and west between a branch of Montour Creek and the Ohio River, retains the Pittsburg coal and, consequently, the disintegrated limestones and limy shales that accompany it, the effects of which are evident in the greater fertility of the soils.

Along the river the soils are formed by the alluvium and the debris brought down by this stream in the past ages and are fertile and adapted for raising market gardening crops. Terraces of ancient origin extend along the river. The first is about 30 feet above low water mark. Upon it the towns and villages along the river have been built.

Some of this section is used for market gardening crops to which well nigh all of it is adapted. The second and third terraces are about obliterated by erosion, but the fourth, which is usually separated from the third by a ravine, makes a broad plan extending back from the river on both sides for a distance of several miles to a series of low hills which separate it from the upland hills already referred to. These soils are derived from the underlying strata which are sometimes shales and again sandy shales and the sand and clays of the terrace. They are fairly fertile and will with good cultivation and the application of lime and manure and the plowing down of heavy sods for vegetable matter in the soil produce well. The southern and western parts of the township are entirely underlaid with the barren shales and the soils are clayey or sandy or shaly as the underlying rocks are the clays derived from the easily disintegrated shales, the sandy from sandstones or sandy shales. All these soils are in need of lime, manure and vegetable matter.

FINDLEY TOWNSHIP

Findley township lies south of Moon and occupies the southwestern corner of the county. The outcropping rock strata extend from about 100 feet above the Pittsburg coal vein to approximately 200 feet below it. On the Divide between Montour Creek in this county and Raccoon Creek in Beaver county, the Pittsburg coal and its accompanying strata are retained with its usual result of a better soil, because these strata contain a larger percentage of limestone and limy shales though about completely disintegrated here their salient effects are very evident. Some of this land is rolling and easily farmed while other parts are hilly and difficult to farm, and should, therefore, be kept in blue grass and be pastured.

The loamy, gravelly and shaly soils of this formation will produce large crops of a splendid type of potatoes. They are also wheat producing soils. The remainder of this township is underlaid with the barren coal measure, shales, sandy shales and sandstone, and the soils derived from these are similar to those previously described in Moon township.

ROBINSON AND NORTH FAYETTE TOWNSHIPS

Robinson township lies east of Moon township and has the Ohio River for its northern boundary while North Fayette lies west of Robinson. The rock strata which forms the basis of the soils of

Robinson, range from 200 feet above the Pittsburg coal vein to about 450 feet below it. Wherever the Pittsburg coal strata remain, the soils are fertile because as so frequently stated of the limestone and limy shales accompanying them. These two townships form sort of a Divide between Montour Creek on the west and Robinson Run on the east and Chartiers Creek on the northeast. The uplands forming the divides between these two streams and their tributaries have soils derived from the strata above or immediately below the Pittburg coal vein while those on lower levels are derived from the barren coal shales. Here we have oak forests on the uplands and beech maple and birch on the lowlands. Here the farming should be done on the upland and the pasturing on the lowlands. Such an arrangement could be introduced. Much of this land is moderately rolling and easily farmed and productive.

South Fayette, Upper St. Clair, Snowden, Scott, Baldwin, Jefferson and Mifflin townships.

These townships have soils formed of similar underlying rock strata. The townships lie between the Monongahela River on the east and Robinson Run and Chartiers Creek on the west and south of the Monongahela and Ohio rivers.

SOUTH FAYETTE TOWNSHIP

South Fayette township lies southeast of North Fayette, on the Washington county line. The strata from which the soils of this township are derived begin about 400 feet above the Pittsburg coal bed. The formation is made up of shales, limy shales and limestone. The great limestone attains a thickness of 40 feet in this township. The soils are fertile, easily farmed where the hills are not too steep.

UPPER ST. CLAIR TOWNSHIP

Upper St. Clair township lies southeast of South Fayette, on the Washington county line. The rock strata from which the soils of this township are derived extend from the great limestone to thirty feet below the Pittsburg coal making if all the strata which intervene between these two formations are present in their full thickness a section of approximately 150 feet all of which may be made up of limestone and limy shales.

Much of this land is very fertile, moderately rolling and easily farmed and being so close to Pittsburg all that is available should be used for raising truck and agricultural crops and the intensive kind of farming should be practiced. All of this applies especially in the vicinity of Bridgeville.

SNOWDEN TOWNSHIP

Snowden township lies east of Upper St. Clair, on the Washington county line. The strata from which the soils of this township are derived range from 300 feet above the Pittsburg coal bed in the northwestern section of the township to 110 feet below in the southeastern part. The fertile land of this township is located in the western and northern sections where the limy shales associated with the upper productive coal strata prevail and make the soils richer.

JEFFERSON TOWNSHIP

Jefferson township occupies the southeastern corner of the county, west of the Monongahela River. Along the river and the streams, such as Piney Fork, where the strata of the lower barren coal measures are exposed, the land is hilly and usually stony; but above these in the upper productive formation which extends only 80 feet above the Pittsburg coal vein the soils are fertile, and what is available should be farmed.

The remaining townships south of the Monongahela and the Ohio rivers and those near the confluence of the Allegheny and Monongahela rivers as well as those immediately north of the Allegheny and the Ohio rivers. are built up with towns and cities or are within town or city limits and are not used for agriculture, and a discussion of these does not come within the scope of this Bulletin.

The townships between the Monongahela and the Youghiogheny rivers, especially Elizabeth and Lincoln, are also covered with towns and cities. The soils throughout these three townships especially, Forward and Elizabeth, are made of the upper productive coal strata and are very fertile. Along the Monongahela River the land is usually hilly but back of this stream it is moderately rolling and easily farmed.

Much of the coal has been mined out and the mines have caved in and have made large acreages of the most fertile land valueless for agriculture or any other purpose. The same thing is true of well nigh all the townships of this county in which the Pittsburg coal vein occurs and where it has been mined out. If the ground has not caved in the water has been taken and capillary action so weakened or in some soils entirely destroyed that crops can get little if any of the water on which they live.

Townships between the Alegheny and the Monongahela and Youghiogheny rivers.

NORTH AND SOUTH VERSAILLES TOWNSHIPS

North and South Versailles are well nigh within city limits. The rock strata from which the soils of these townships are derived range from the Pittsburg coal vein which occurs on the Divide between

Turtle Creek, Jacks Run and Crooked Run and the lower barren coal strata, down to the green crinoidal limestone. This is not an extensive section and not a rich one in soil fertility.

These soils can be made productive and should be, all that remains outside of cities and towns, with lime, and manure which can be readily obtained throughout this section and by methods of farming for fertility.

WILKINS TOWNSHIP

Wilkins township lies northwest of Versailles, with its southern boundary on the Monongahela River. A trough or synclinal in the rock strata crosses the eastern section of the township, and in this trough on the hilltops the Pittsburg coal vein remains and its accompanying strata which make fertile soils. The fertile soils are on the ridge, above the valleys cut down into the lower barren coal strata by the small streams. A very good illustration of this is found along the Greensburg Pike. The hillsides in many places are steep and difficult to work with farm machinery. The soils are fertile because the disintegrated rock of the upper limy strata have worked down the hills and have mixed with the sandy formations and have made productive soils. Beginning with Braddock along the Monongahela River and extending through the western part of this township on to Lawrenceville within Pittsburg on the Allegheny River is a nicely rolling section of country.

PENN TOWNSHIP

Penn township lies north of Wilkins. The strata, like those of Wilkins township range from above the Pittsburg down to the green crinoidal limestone in the lower barren coal measures. The same conditions prevail here as those of Wilkins, the fertile soils are located on the ridges where they are made of the disintegrated limy strata accompanying the Pittsburg coal vein. These soils are adapted as are those of Wilkins township for trucking and in this vicinity should be used for this purpose.

PLUM TOWNSHIP

Plum township occupies the northeastern part of the county east of the Allegheny River. The strata entering into the formation of the soil of the township range from above the Pittsburg coal vein down deep into the barren coal strata.

In the southwestern corner in the vicinity of New Texas and from this place northeastward and southward are the fertile soils of this township. The land is hilly, but the uplands are sufficiently rolling and extensive to do upland farming. The pasturing can be done on the lowlands along the streams and the agricultural crops

raised on the hills. The barren measure soils in the vicinities of the upper coal strata are benefited by these but northward where the coal strata are absent the soils are less fertile. The country is hilly and farming operations attended with difficulties. Patton township is very like Plum.

SOMERSET COUNTY

That part of Pennsylvania, which is now included within the limits of Somerset county, was formerly part of Bedford, from which it was taken, April 17, 1795. It contains 661,760 acres, of which 475,258 acres is land in farms, and of which 258,154 acres is improved farm land. 17,033 acres were planted with corn in 1909, yielding 658,945 bushels; 34,872 acres were sown with oats, yielding 951,335 bushels; 11,420 acres were sown with wheat, yielding 180,097 bushels; 8,755 acres were sown with buckwheat, yielding 177,990 bushelse 3,152 acres were sown with rye, yielding 38,898 bushels; 4,869 acres were planted with potatoes, yielding 573.109 bushels; 63,718 acres were sown with all forage crops, yielding 73,315 tons of the various kinds of hay. Of the 258,154 acres of improved farm land, 143,819 acres were used for raising farm crops while 155,335 were not so used and were likely producing weeds. At this time Somerset county had a population of 67,717 to feed, 34,338 cattle, 9,986 horses, 90 mules, 17,354 swine, and 14,499 sheep.

The rock strata which outcrops in this county and form the basis of its soils, begin with the Chemung shales, followed by the Catskill sandstones and shales. the Pocono sand, the Mauch Chunk red shale, the Pottsville conglomerate, the lower productive coal measures or the Allegheny series, the barren measures or Pittsburg series and the upper productive coal measures or Monongahela series.

The county divides itself into four sections: The first, the southeastern section, composed of Southampton township; the second, of Allegheny, Northampton, Larimer and Greenville townships, lying east of the crest of the Allegheny Mountains, and nearly outside of the bituminous coal field of western Pennsylvania except Southampton township which contains a semi-bituminous coal basin; the third section, going westward, lies between the Allegheny and Negro mountains and contains Elk Lick, Summit, Brothers Valley, Stony Creek, Shade and Paint townships; the fourth section lies between Negro Mountain and Laurel Hill which forms the boundary between this Fayette and Westmoreland counties and contains Addison, Lower Turkeyfoot, Upper Turkeyfoot, Middlecreek, Jefferson, Lincoln, Jenner and Conemaugh townships.

The Pottsville conglomerate rocks forming the crest of the Allegheny Mountain, goes under, reappears on the crest of Negro Mountain, goes under again and reappears on Laurel Hill, which forms the western boundary of the county. In the Salisbury basin, between the crest of the Allegheny and Negro mountains, in a distance of eight miles, all the rock strata up to and including the Pittsburg coal bed, take part in the formation of the soils, as far north as the Castleman River at Summit Hill. The lower productive coal rock strata come here immediately above the Pottsville conglomerate, and where these strata outcrop, along the side and foothills of the Allegheny and Negro mountains they form a rough and stony soil in many places unfit for farming but sufficiently clean for growing apples for which the soils are well adapted. Where the lower barren strata and the lower productives intermingle, and where the lower barrens alone (which are composed of easily disintegrated shales) form the soils, the hills are moderately sloping and rounded the soils are deep and so well disintegrated that they have become clays. In the central part of this basin the rock strata of the upper productive coal measures form the soil. Among these strata occur three limestone beds, the highest one 10 feet thick, overlaid with a thin coal bed, the second, 8 feet thick also overlaid with a thin coal seam, and a third, 8 feet thick similarly overlaid with a coal seam. These strata form moderately sloping hills with an abundance of limestone (and coal sufficient overlaying it to burn the lime) making soils not excelled in fertility anywhere in the State.

Southampton township, in the southeastern corner of the county, is the smallest of the four divisions into which the county is geologically divided and contains the northern limits of the Cumberland semi-bituminous coal basin coming in from Maryland, about 10 miles long and 2 and a half miles wide. This basin is surrounded by a mountain—the Allegheny already referred to in the description of Bedford county—of Pottsville conglomerate, Mauch Chunk red shale, and Pocono sand and is not adapted for farming, except in the southern section, about Wellersburg where the limestone shales and the limestone of the coal measures make a fertile soil, well adapted for wheat and grass especially such pasture grasses as Kentucky blue grass, while some of the more hilly and rough soils are adapted for fruit growing.

GREENVILLE TOWNSHIP

Greenville township, bordering on the Maryland line, forms the southern section of the second division and lies between the little Savage and Allegheny mountains, both made up of the Pottsville conglomerate, terraced with Pocono sand, with an intervening section of Catskill sand and Chemung shales, very little of which is adapted

to agriculture and should be maintained in forest or be reforested.

Larimer township, which is separated from Greenville by Flaugherty Creek, is made up of the same formations and has, therefore, similar adaptations.

Northampton, through which the B. & O. R. R. has run its lines, is made up of the same formation and has little land that is valuable for agriculture except in a few of the valleys, and the flat topped hills such as are found in the vicinity of Glencoe, in the Chemung shales, where some apples are raised, for which the soils are adapted.

Allegheny township is more elevated than the two previous townships and not any more adapted for agriculture.

ELK LICK TOWNSHIP

Elk Lick township west of Greenville and bordering on the Maryland line and having its western boundary on Negro Mountain, is one of the best agricultural townships of the county. In the vicinity of Salisbury and extending beyond the border of this township into Summit, is preserved quite an area of the Pittsburg coal seam, which here is accompanied with a limestone formation of a thickness of 8 feet. Wherever this limestone is preserved in this county, it occurs on top of the hills as at the Keystone lime kilns, a little north of the Maryland line, in this township. The limestone here is directly under the coal vein. In some places the coal has been washed away and the limestone has been disintegrated and has formed a gravelly soil of a very superior type, a soil that will produce crops in wet or dry seasons, with little injury from either condition. On the hills and the hillsides where the coal seam remains or where it has been washed away and the limestone gravel remains, the soils are dark colored considerable distances down the hillsides and consequently the peculiar phenomena occurs of having fertile soils and oak forests on top of the hills and stony and rocky soils and pine forests on the lower hillsides, and of having Kentucky blue grass and clover pasture on the hilltops and along the hillsides as far down as the salient effects of the limy disintegration extends; and below this in the barren coal measure soils, daisy pastures. This is not so manifest where the pasture has been pastured to death, as unfortunately is frequently the case. But where this has not been done, the daisy rim is very obvious.

On the eastern slopes of Negro Mountain, are some of the gravelly soils made of disintegrated shales of the lower productive coal measures mixed with sand. These soils do not wash or only when there are abnormal rains. All kinds of farm crops do well, especially when well cultivated. Apple trees thrive here and were laden with fruit when this examination was made. In many places on the lower parts of the hillsides, the sand rocks and stones of the barren

measures completely cover the ground, especially where the Pittsburg coal vein is found as at Salisbury. Where this is the case, sugar maples are grown and the manufacture of maple sugar during the early spring is a fairly paying industry, at a season when farmers are not very busy. On the western slopes of the Allegheny the soils are derived from the same underlying strata, as those of the eastern slope of Negro Mountain, are more rugged, less fertile and the land steeper.

SUMMIT TOWNSHIP

Summit township, directly north of Elk Lick, has already been referred to, and with the exception that it does not contain as large a territory of the Pittsburg coal bearing strata, and that the Negro Mountain is not as high and rugged as in Elk Lick, and the Castleman River flows through it, in a northwestern course forming some fertile valleys and in its course exposing some of the lower limestone veins that make lime and that the B. & O. R. R. has run one of its main lines through the township, is very similar to Elk Lick, in soil formation, fertility and agricultural practice.

BROTHERS VALLEY TOWNSHIP

Brothers Valley township, north of Summit, is one of the most fertile farming districts in the county, especially in the vicinity of Berlin. The soil made up of the lower barren easily disintegrated limy shales, is fertile and forms farming district, equal in fertility to that of any section of the State. The land is easily farmed. Four limestone veins occur and these, together with the shaly strata, occurring here, enter into the formation of the soil of this section. The limestone and the coal veins of this section occur so close together that the limestone can be burned where it is quarried and lime made at small expense. The Elk Lick limestone outcrops on the surface on top of the hills in many places in this section.

This is one of the places where intensive farming of a high order could and should be practiced, because the soil is deep and fertile, to its full depth and will, with fair agricultural treatment, produce good crops indefinitely. The Allegheny Mountain forms the eastern boundary of this township with soils derived from the lower productive coal measures and the conglomerates. The lower productive coal measures make the soil and a rolling country in the western part of the township in which occur limy shales and limestone and therefore wherever these occur, fertile soils are produced. In the southwestern part of the township the conglomerates come to the surface and make a rough and barren country.

STONYCREEK TOWNSHIP

Stonycreek township lies north of Brothers Valley and east of Allegheny, in the Berlin basin. The soils of the township are formed of the lower barren and the lower productive coal strata and the conglomerates. In the southern part of the township the lower barrens overspread the whole township, except the outcrop of the lower productives and the conglomerates along the Allegheny Mountain. The barren strata here partakes of the character of the Berlin formation and are more easily disintegrated than usual and consequently form a more fertile, more easily farmed and more productive soil. Northward at Shanksville in the central part of the township, the lower barren measures remain in the hills while the lower productive series form the soil of the hillsides. In the western part of the township on a Divide between Stony Creek and a branch flowing in from the town of Friedens, the lower productive strata form the soils entirely and from this place northward to the northern extremity of the township. At Buckstown the country is hilly, and while there is considerable farming land throughout this section, farming except on the uplands which are moderately rolling, is attended with difficulties.

Limestone, the Upper and Lower Freeport, and in a few places, the ferriferous, occur along Rhodes and Calender runs, and Stony Creek, usually so close to coal seams that the stone can be burned where it is quarried.

SHADE TOWNSHIP

Shade township lies north of Stonycreek with the Bedford county line for its eastern boundary. A Divide between Stony and Dark Shade creeks extending from Buckstown northward to some distance southeast of Hooversville, is an upland section of rolling land with quite fertile soils. On the slopes of these hills where the coal shales outcrop, the soil is usually deep and does not wash so readily and farming can be successfully carried on. These upland slopes usually occur along Dark Shade Creek, Fallen Timber Run and smaller streams. The eastern part of this township is extremely rough and hilly and has very little land adapted to farming. Some soils here are very well adapted for apple growing and some for pasture for which they should be utilized. The western part of the township is not as hilly and the soils along the streams, and the uplands are similar to those of Stonycreek.

PAINT TOWNSHIP

Paint township occupies the northeastern corner of the county, adjoining Bedford and Cambria counties. The soils are derived from the same strata as the township previously described, except, that

some clearing has been made on top of the mountain where the Mauch Chunk red shale and the Pocono sandstone intermingle in the formation of the soil. The land is rather easily farmed and could, with the application of manure and lime, be made productive. The silicious limestone occurs only a short distance west of this place and would it seems, if ground finely, help to make this soil productive. Apple raising, it seems could be made a paying business here.

The conglomerates make this an inhospitable section where timber that thrives in the poorer lands only, thrives. The areas of Shade and Paint creeks have a few of the limestone veins of the lower productive series of sufficient purity and quantity to supply the lime that is needed in this section. From Ashtola southwestward is some rolling upland sufficiently clean and rolling to farm but poor and thin. Through the central and eastern section of the township the land becomes more rolling especially in the eastern part, at such places as Windber and Scalp Level on the line between this and Cambria county. The soil in a large part of this eastern section, can with good agricultural practice be made very productive.

ADDISON TOWNSHIP

Addison township occupies the southwestern corner of this county, with the Fayette county line for its western boundary. The eastern boundary line runs along the crest of Negro Mountain. The strata from which the soils are derived range from the lower barren, through the lower productive coal measures, down into the Pocono sandstone which covers Negro Mountain.

At the eastern boundary of this township is a Divide between Whites Creek, flowing westward and the tributaries of Tub Mill Run flowing eastward. Whites Creek flows rapidly westward through a narrow gorge, from this ridge, elevated about 800 feet above the streams, at Listonville along its western course. Along the gorge of this stream, the silicious limestone crops out at the base of the Mauch Chunk red shale. One section of it burns easily into a white lime, which slacks readily and makes a good lime for mortar and for plastering and for use on land. The stone was also used in the construction of the National Pike, which passes through this ridge, a few miles south of this gorge. North of the outcropping of the Mauch Chunk red shale, at the heads of Glade Run and Town Line Run flowing westward and Elk Lick Creek flowing eastward, to a Divide from which the eastward descent is rapid, while the westward slope is more gradual and the land more rolling, and not so steep as farther south. This Divide of rolling land prevails both in this and Black township. Along Whites Creek, at Listonville, the land is hilly. while farther south along Club Run, in the same formation it is more moderately rolling.

The western part of the township lies entirely in the lower barren coal series, with rolling upland three to four hundred feet above the Youghiogheny River which makes the western boundary of this township and the county. The Elk Lick limestone crowns the rolling and hilly uplands in this section and makes fertile soils. Confluence on the northern border of the township is surrounded with high hills, of the barren measures on which the Elk Lick limestone outcrops and enters the formation of the soil.

LOWER TURKEYFOOT TOWNSHIP

Lower Turkeyfoot lies northwestward of Addison on the Fayette county line. The strata from which the soils of this township are derived, range from the barren coal measures, down to the conglomerate sandstone which covers the western part of the township. In the southwestern part of the township between Laurel Hill Creek and Draketown Run, is high rolling upland much of it made fertile because of the presence of the Elk Lick limestone in the strata that form its soils, as well as limy shales and clays and likely the limestone seams that form the soils at Berlin, and like the Berlin section, are adapted to intense farming. The Elk Lick limestone in this section is said to be ten feet thick. The following analyses of an average sample of the stone from near Ursina in the southeastern part of this township gives its composition:

Carbonate of lime,	90.803%
Carbonate of magnesia,	2.738%
Carbonate of iron with alumina,	1.986%
Sulphur,	0.084%
Phosphorus,	0.048%
Insoluble residue,	3.740%
	99.399%

This limestone occurs on top of the high plateau. The lower productive coal strata make the soil at Draketown and thence northward along Drakes Run and along Cranberry Glade Run and along Laurel Hill Creek. Here the land is hilly but the soils are fairly fertile. Westward from the lower productive coal measures, the conglomerates make the soil. Some rolling land along Cranberry Glades Run is quite unproductive.

UPPER TURKEYFOOT TOWNSHIP

Upper Turkeyfoot lies east of Lower Turkeyfoot and north of Addison township. The lower barren and lower productive coal strata and the conglomerates form the soil. The whole of the eastern

part of the township is occupied by a Divide between the Casselman River and Laurel Hill Creek, the soil of which is derived from the barren series. Along the river, at Pinkerton and Casselman, on the eastern border of the township, the hills of these barren coal series rise high above the stream.

This township is nearly entirely made up of highlands. Among the hills of the barren section, already referred to, are deep well disintegrated soils. which, wherever the limy shales and the limestone occur, are naturally fertile, very similar in formation and fertility, to those previously described in other townships.

BLACK, MILFORD AND MIDDLECREEK TOWNSHIPS

Black, Milford and Middlecreek townships are very similar in the formation of their soils. In each one of them, the outcropping strata range from the barren measures down through the lower productive strata into the conglomerates. The conglomerates form the soil in the eastern part of Black township from Town Line Run north to the Casselman River. As usual, the soil is rough and not fertile and poorly adapted to farming. In the south central part of the township, where the soil is derived of the lower productive coal strata, the land is rolling and easily farmed, though not as fertile, as the lower barren strata soils usually are in this county. Along the Casselman River, in the western part of the township, are some upland soils that are partially derived from lower barrens and lower productive strata which are more fertile than the lower barrens. In the northwestern part of the township, the land is moderately rolling, in some places gently rolling and in places even flat and too wet for successful farming, without underdraining.

This section is in the lower productive series. Some limestone and coal veins occur here. At Rockwood, in the southeastern part of Milford township, the land is hilly. The Freeport sandstone of the lower productive coal measures occupies the hills and produces much rough country.

From Rockwood to New Centerville, also in the southern part, after reaching the top of the hills, the land of these lower productive strata becomes more rolling and soils easily farmed, of fair fertility and with good agricultural practice are made very productive. At New Centerville this rolling formation continues, in fact it becomes gently rolling and in some places even flat and the land so level that underdraining is necessary for best results. This land underdrained makes the best farming land in this section. Deep tillage machinery might break up the soil and subsoil to such depths and make the impervious clay the cause of the wetness, pervious and the land tillable during normal seasons, or even during wet seasons. Similar

conditions prevail in the central part of this township, with some higher hills, while in the northern part, the barren strata becomes the basis of the soil and make a rolling country, with soils of fair fertility.

Between New Centerville and New Lexington, in the southeastern part of Middlecreek township, a transition from the lower productive to the lower barren strata takes place and the soil of the rolling land, on the New Lexington plateau, is derived from these strata. This upland formation begins north of Ursina and extends northward through New Lexington into Jefferson township, with soils of similar formation.

The central part of this township is hilly, with some fertile farming land suited especially for grazing and some of the higher elevations for apple growing. The western section runs along the mountain and there is little farming land here.

SOMERSET TOWNSHIP

Somerset township lies north of Milford and Brothers Valley and west of Brothers Valley and Stony Creek townships. Somerset, the county seat of the county, is located in this township. The strata from which the soils of this township are derived, range from approximately the middle of the barren coal shales down into the top of the conglomerates. The Divide between the Casselman River to the south and the Conemaugh in Cambria county, passes approximately along the Bedford and Somerset Pike. At Fairview and vicinity, at the headwaters of Kimberlin Run, in the eastern part of the township, the soil is formed of the lower barren strata. The country is rolling and the soil more fertile than usual, in the lower productive coal strata. A limestone seam of some value outcrops beneath a coal vein and enters into the formation of the soil throughout this vicinity; of which the following analysis gives the composition:

Carbonate of lime,	63.969%
Carbonate of magnesia,	4.244%
Carbonate of iron with alumina,	4.393%
Sulphur,	.385%
Phosphorus,	.142%
Insoluble residue,	24.780%
	97.913%

The soil in many places is sandy and not fertile. On Kimberlin Run, the Freeport sandstone forms the Breakneck rocks. This same sandstone covers the soil along these streams. North of Fairview toward Friedens where the lower barren coal measures and

the lower productives together produce or form the soil, the land is more fertile and a smooth and rolling country is the result. At Husband, where the lower barrens and the lower productive form the soil, the land is moderately rolling the soil fertile, making a splendid farming section, in which are located some of the best farm buildings in the county. Somerset is located on the east branch of Coxes Creek, on the border between the barren and lower productive strata. Eastward and northeastward from the town the lower productives as already indicated, make the soil. Southward along Coxes Creek, the Freeport sandstone makes some rough country.

Southwestward the country is hilly, but the soil is usually fairly fertile while northwestward is a magnificently rolling section. In short, Somerset township is one of the richest farming districts in the county. Looking from the hills of the town of Somerset, extending in every direction is a magnificent undulating country not easily equalled in any section of the State. Between Somerset and Lavansville, north and south of the Somerset and Bedford Pike, on the barren coal strata is splendid farming land, alfalfa is successfully raised in this section by a number of farmers. The plants are thrifty and have the nodular formations on the roots, showing, that these soils are ready for raising this valuable forage crop. A number of limestone outcrops occur in the hills throughout this sectoin. These may be the limestone of the Berlin formation or the black fossiliferous limestone which outcrops south, east, and west of Lavansville. It is an impure stone but its effects on the fertility are every where in evidence in the vegetation, in the forest and the crops on the farm. At Geiger station, north of Somerset and westward from this place the same rolling land continues.

JEFFERSON TOWNSHIP

Jefferson township lies west of Somerset on the Fayette county line. The lower barren and the lower productive coal measures and the conglomerates form the basis of the soils of this township. The eastern and southeastern parts of the township are very similar to Somerset township. As already intimated, the New Lexington plateau or Divide between Middle and Laurel Hill creeks, attains its greatest height at Indiantown in the southeastern part of this township where an elevated rolling upland section occurs, with productive soils easily farmed, adapted to all agricultural crops that will thrive in this climate. At Bakersville and north and south of this place, the soil is formed by the intermingling of the lower barren and productive coal measures and is not as fertile as the soils of the barren measures alone. Some of the land along the streams is low and in some places wet and stony and difficult to farm. This condition prevails north and south of the high Divide, already referred

to in Somerset township, and which passes through this township near the northern border. At the Neidheiser place in the western part of this township along Laurel Ridge, in connection with the Mauch Chunk red shale. a silicious limestone outcrops and where sufficient disintegration has taken place, makes a fertile soil. From the luxuriance of the tree growth along this formation it seems that apples and other fruit should thrive here.

LINCOLN TOWNSHIP

Lincoln township lies north of Jefferson and Somerset townships. The strata from which the soils of this township are derived, range from the lower barren measures through the lower productive series, through the conglomerates down to the Mauch Chunk red shale. This township lies on the north side of the Divide, from which the streams flow northward into the Conemaugh River. This upland of the lower barren strata is rolling and in the eastern part of the township, northward from Allenvale, is one of the rich farming sections of this township, with limestone in sufficient quantity, in close proximity to the coal to burn the stone where it is quarried. At Sipesville is a magnificent upland country, of moderately rolling land. The western part of this township contains the same soil formations as Jefferson township.

QUEMAHONING TOWNSHIP

Quemahoning township lies north of Somerset, east of Stonycreek, and Shade townships. Nearly the whole of this township is covered with the barren measure strata, except, along Quemahoning and Stony creeks and the smaller streams, such as Beaver Run, where the lower productive strata, sometimes enter into the formation of the soil. At Stoyestown, along this stream, is some of the soil of these lower productive coal measures. Along Stony Creek, near Stoyestown, an outcrop of limestone occurs close to a coal seam likely the Lower Freeport coal bed. This stone is quarried here and burned with the overlying coal, where it is quarried. The following analysis gives its composition:

Carbonate of lime,	88.139%
Carbonate of magnesia,	1.854%
Carbonate of iron,	1.798%
Alumina,	0.340%
Sulphur,	0.457%
Phosphorus,	0.023%
Insoluble residue,	5.640%

This makes a fair agricultural lime. Several similar limestone veins occur in the barren shales, and wherever these come to the surface and enter the formation of the soil, their influences are shown. The whole township is hilly, similar to the Stoystown section, but among the hills are fertile and well farmed farms. These soils are especially adapted for raising wheat, potatoes and clovers, especially where the limestone and limy shales prevail. When this examination was made the corn crop was promising.

JENNER AND CONEMAUGH TOWNSHIPS

Jenner and Conemaugh townships occupy the northwestern corner of the county, with soils derived from the strata of the lower barren and lower productive coal measures, the Pottsville conglomerate and a little Mauch Chunk red shale. Along Laurel Hill Ridge. in the eastern section of the township, along the Quemahoning Creek or along the upward curvature of the strata, caused by an anticlinal that passes through this part of the township the lower productive strata form the basis of the soil from Sipesville in Lincoln township northeastward to the township line. A number of limestone veins crop out all along this formation and make it possible for the farmers to get lime at small expense because the stone can be burned with the coal close by. The soil is fertile wherever the limestone enters its formation, but wherever the sandy strata form the soil it is usually lean. The following analysis gives the composition of one of these limestone veins near Sipesville along the southern border of the township.

Carbonate of lime,	79.478%
Carbonate of magnesia,	10.222%
Carbonate of iron and alumina,	3.639%
Sulphur,	0.168%
Phosphorus,	0.034%
Insoluble residue,	4.970%

From Jenner westward the barren strata make the basis of the soil, in a hilly country but one with some fertile sections. This same formation extends northward to Forwardstown near the northern boundary of the township. Here, as at Berlin, a similar number of limestone strata enter the formation of the soil, of which Elk Lick is the highest, with a number of outcrops. The following analysis gives the composition of the stone at this place:

Carbonate of lime,	89.522%
Carbonate of magnesia,	5.327%
Carbonate of iron,	1.812%
Alumina,	0.224%

Sulphur.	0.245%
Phosphorus,	0.016%
Insoluble residue,	2.500%

This stone makes a good agricultural lime. Another limestone outcrops about one mile south of Forwardstown. It has the following composition:

Carbonate of lime,	80.588%
Carbonate of magnesia,	8.445%
Carbonate of iron,	3.314%
Carbonate of manganese,	1.400%
Phosphorus,	.026%
Bisulphide of iron,	0.371%
Alumina,	0.455%
Insoluble residue,	4.805%
	99.402%

This does not mean that these limestone strata outcrop throughout this whole section but that these seams show that throughout this whole region, the barren measures form a superior soil to that usually formed of the barren measures, outside of this county. West of these upper strata is a narrow strip of lower productives, that make the soil along with the conglomerates which extend nearly to the summit of Laurel Hill and which here forms a sandy soil of poor quality. On top of Laurel Hill is a broad flat on which the Mauch Chunk red shale and mountain limestone form the soil. It seems that this soil should be adapted for raising apples. This matter was not investigated. Conemaugh township is very similar in soil formation to Jenner except that the upper barren formation seems to cover a larger area of the township.

Somerset county has, as is indicated in the discussion of the townships, a wide variety of soils, in which all the types are represented, from the stony and gravelly, down to the fine clays. Corn, wheat, oats, in fact all the cereal grains thrive in the more fertile soils throughout the county, while buckwheat and the hay grasses thrive in the higher elevations and the poorer soils. Splendid apple soils range along the mountains and mountain sides in the three divisions of the county. No better anywhere in this southern section of the State. Peaches will thrive here also. This should be mainly a stock raising county. The elevations above tide, in the county range from 1,346 feet at Confluence to 2,843 feet on top of Negro Mountain The railroad facilities and trolley lines are good, but should be extended.

WESTMORELAND COUNTY

The General Assembly on the 26th of February, 1773, passed an act by which Westmoreland county was established. It contains 664,960 acres, of which 375,557 acres is land in farms, and of which 369,635 acres is improved farm land. 39,489 acres were planted with corn in 1909, yielding 410,787 bushels; 36,948 acres were sown with oats, yielding 930,529 bushels; 28,920 acres were sown with wheat, yielding 396,357 bushels; 2,571 acres were sown with buckwheat, yielding 44,559 bushels; 2,130 acres were sown with rye, yielding 24,513 bushels; 4,540 acres were planted with potatoes, yielding 378,139 bushels; 80,747 acres were sown with all forage crops, yielding 91,097 tons of the various kinds of hay. of the 369,635 acres of improved farm land, 195,345 acres were used for raising crops, while 174,290 acres were not so used and were likely producing weeds. At this time Westmoreland had a population of 231,304 to feed, 36,209 cattle, 15,474 horses, 886 mules, 24,978 swine and 14,764 sheep.

Westmoreland county lies south of Indiana and Armstrong, east of Allegheny, north of Fayette and west of Somerset. The geological strata which form the soils of this county are derived, according to the Second Geological Survey of Pennsylvania, range from the Catskill, which occur only in a narrow strip along the Conemaugh River, on the northern border of the county, through the Pocono, the Mauch Chunk red shale, the conglomerate, the lower coal measures, the Upper Freeport coal, the lower barren measures, the upper coal measures and the Pittsburg bed, and small patches of the upper barren measures.

The U. S. Survey makes five divisions of the formations as they exist, beginning with the formations below the Pottsville: The Pottsville, the Allegheny, the Conemaugh, the Monongahela, with a few small patches of the Dunkard group, the highest strata in the State.

The county is drained by Jacob's Creek, which forms the southern boundary from Chestnut Ridge to the Youghiogheny River. This river, with its tributaries, drains the southwestern sections. Sewickley Creek drains the county north of Jacobs Creek, from Chestnut Ridge westward. The Loyalhanna, flowing from the Ligonier Valley, drains the county between the Conemaugh and Sewickley. Little Sewickley, Brush Creek, Turtle Creek and Pinketta drain the western part of the county into the Monongahela and Allegheny rivers, while smaller streams flow northwest into the Kiskiminetas.

Discussion of townships, beginning with the township in Ligonier Valley all of which have approximately the same soil formations:

DONEGAL TOWNSHIP

Donegal township lies in the southeastern corner of the county in the Ligonier Valley. The rock strata exposed begin 450 feet above the Upper Freeport coal bed in the barren strata and extend down to the Pocono sandstone, which comes to the surface along Laurel and Chestnut ridges. Laurel and Chestnut ridges are the highlands which parallel the so-called valley in the central part, of which the lower barren coal strata are the underlying rock.

From this it is evident that this valley is a synclinal or trough and that the strata which outcrop on the side ridges are covered with many hundred feet of strata much higher geologically than the side ridges. This is true of Donegal township. The lower strata geologically are topographically higher while the higher strata geologically are topographically lower.

The valley itself is hilly to such an extent that it is difficult to locate the ridges except by the underlying strata. First, on top of the ridge is the Pocono which is usually too rough for farming; then comes the Mauch Chunk red shale whatever there is of it; then the conglomerate, which does not seem to occur here; then the lower productive coal measures, which occupy a strip varying in width from one to two miles. This section contains the best farming land of the township, but it is hilly and difficult to farm.

The barren measures are more shaly in this section and, therefore, disintegrate more readily and form a more fertile soil than do the more sandy strata of this formation. Along the main stream of Four Mile Run, the black fossiliferous limestone crops out and is sufficiently pure to make lime.

COOK TOWNSHIP

Cook township lies directly north of Donegal, extending across the Ligonier Valley. The strata outcropping in this township range from 200 feet below the Pittsburg coal bed down to the Pocono sandstone, therefore, the soils in the valley, especially on the more elevated sections, are derived from the barren shales and sandstones, while along the sides of the valley and along the streams in the valley the soils are derived from the strata of the lower productive coal shales, sandstone and limestones.

This is the exact condition as found upon investigation. Along the Loyalhanna Creek, which rises in the southern part of this township on a Divide between it and Indiana and flows northward along the foot of Laurel Ridge, are some fairly fertile farms, but usually hilly and rough. The same is true of the county along Four Mile Run which flows along the ridge in the western section of the township.

Along the sides of Ligonier Valley as well on the barren shales of the central part of the valley, are the fruit soils of this and Donegal townships; or for that matter of Westmoreland county, and wherever possible, this land should be used for this purpose. Apple trees grow luxuriantly along these hills and apparently bear well.

As already indicated, the barren strata are not as sandy here as in some other sections and, therefore, disintegrate and form more clayey soils, deficient in lime, which become hard when dry, and soggy when wet and are difficult to handle, but with lime and vegetable matter derived from manure or from plowing down sods these soils can be made among the best wheat, oat, buckwheat and timothy soils in the State.

LIGONIER TOWNSHIP

Ligonier township lies north of Cook township, with its eastern line on the crest of Laurel Ridge and its western on Chestnut Ridge. The outcropping rock strata extends rom 110 feet above the Pittsburg coal vein down to the Pocono sandstone.

The soils are similar in formation throughout this township to those already discussed, except that the Pittsburg coal measures take part in its formation in several sections south of Ligonier and several sections north of this town. The lower barren measures are shaly and the soils need amendments in the way of lime, manure and fertilizer. These soils are very deficient in nitrogen, which should be supplied by adapting a system of cropping in which the clovers occupy a prominent position.

About a mile east of Four Mile Run and about three miles southwest of Ligonier, two knobs rise high enough to catch the Pittsburg coal vein and the limestone vein sixty feet beneath it from 4 to 5 feet thick. This limestone when burned makes a good agricultural lime. The coal and the limestone are so close together that with little labor the lime can be burned at the quarries and in this way, lime to apply to these barren shale soils can be made at little cost. The superior fertility of the soils on these hills changes the aspect of the timber.

North of Ligonier on the dividing ridge from which the water flows southward into the Loyalhanna and northward into the Conemaugh, a considerable territory of the Pittsburg coal formation remains. In the vicinity of the town of Ligonier, where the Loyalhanna and Mill creeks meet, is some meadow land apparently of good fertility. Northeast and southwest along these streams are some splendid upland sections, some of them rising high enough and extending far enough northward to catch the Pittsburg coal formation to the north, and southwestward, to catch the small area of the same formation near Ligonier.

The soils derived from the strata above the Pittsburg coal and of those immediately underlying it are very different from those of the barren strata because they contain limestone and limy shales, as is shown in a rock section of a little over a hundred feet in this part of the township which contains from 12 to 14 feet of limestone and approximately 40 feet of carbonaceous shales above the Pittsburg coal seam which is more lime than is contained in the more than 500 feet of the lower barren series. The limestone and coal are so close together that the lime can be burned with the least possible expense. These soils produce all agricultural crops that thrive under the climatic conditions prevailing here.

In the gap made by the Loyalhanna through Laurel Ridge the silceous or Loyalhanna limestone crops out in a vein 40 feet thick. It is a magnificent formation. The stone from this formation has been burned and used for agricultural purposes.

FAIRFIELD TOWNSHIP

Fairfield township lies north of Ligonier and has the Conemaugh River for its northern boundary. The strata from which the soils of this township are derived range from about 200 feet above the Pittsburg coal bed, down to the Pocono sandstone. The highlands in the southern part of the township, already referred to, in which the Pittsburg coal formation remains, have soils constructed of the same strata, discussed in Ligonier township, except that the area is larger and that a limestone vein six feet thick outcrops on top of this section which does not occur in Ligonier township.

The soil is fertile and adapted for raising all agricultural crops. Potatoes, wheat and the clovers should thrive well here, while apples should find a congenial soil and climate on the hills of the barren strata and along the slopes of Laurel and Chestnut ridges. Sufficient limestone and coal occur throughout this section to furnish lime for all time, for agricultural purposes. Westward from this higher section, geologically, the land becomes more rolling and the distance between the two ridges apparently becomes greater.

At Bolivar the land is hilly, but eastward from this place as the central part of the valley is approached, the land becomes moderately rolling and adapted to raising the grasses such as timothy. At West Fairfield is one of the rolling sections with soils derived from the more shaly strata of the lower barren series. Northwestward across the Conemaugh the land is level or nearly so and some of it low and wet.

ST. CLAIR TOWNSHIP

St. Clair township lies north of Fairfield and occupies the northwestern corner of Westmoreland county. The strata from which the soils are derived range from about 400 above the lower productive

coal formation down to the Pocono sandstone. From New Florence, southwestward, the land on the barren shales is rolling and of fair quality, not difficult to farm, but as the mountain is approached the soil becomes stony and rough and difficult to farm. The elevation above tide in the gorge of the Conemaugh is 1,184 feet, at Nineveh Station 1,121 feet and at Mill Creek, Ligonier township, 1,135 feet.

MOUNT PLEASANT TOWNSHIP

Mount Pleasant township lies largely west of Chestnut Ridge. It has the Fayette county line for its southern border and adjoins Donegal township on the east. The strata from which the soils east of the mountain are derived range from the Morgantown sandstone down to the mountain or Umbral limestone. The soil east of the mountain upon the Divide between the headwaters of Jacobs Creek, Four Mile Run and the headwaters of big Sewickley Creek is more fertile and more moderately rolling than the slope of the mountain elsewhere. From all indications it seems that this should be well nigh an ideal orcharding section.

The soil is largely derived from shales and is loamy and takes up and retains a large amount of moisture, all of which is very desirable for fruit growing as well as for the production of all other crops. The part of the township west of the ridge belongs to the Blairsville trough in which, beside the western section of this township, parts of east Huntingdon, Unity and Derry townships are located.

The strata from which the soils in this part of the township are derived range from the Waynesburg coal bed down to the Umbral or silicious limestone, which means that this trough is so deep in this township that it holds all of the strata of the upper productive coal formation, all of the barren measures and a large section of the conglomerate.

In the central part of the trough, the limestone, the limy shales, the shaly sandstone, accompanying the Waynesburg coal seam, form the soil. Further east and west of this central section as well as south of it, at such places as Mt. Pleasant the strata, overlying the Pittsburg coal bed, form the soil.

With the limestone and limy shales accompanying these formations, the soil in this central basin is fertile, the land moderately rolling, adapted to the production of all agricultural crops that will thrive in these climatic conditions. The great limestone, or the lower portion of it, is from 12 to 15 feet thick south of Mt. Pleasant. When burned it makes a lime of superior quality, splendidly adapted for all argicultural purposes. This limestone occurs in many places in this central section, and enters into the formation of the soil.

The lower barren coal strata do not do as much harm in the formation of the soil along the foothills of Chestnut Ridge, because

the section is narrow and the strata are shaly, easily disintegrated, forming more rounded hills less liable to washing and a more productive soil.

The lower productive strata form the face of the mountain along Chestnut Ridge and, as already indicated, in the southern part reach almost to the ridge. Here are some sections of fertile soil adapted especially to fruit raising for which they should be used. The more limy formations, though these are mostly narrow, are well adapted for raising potatoes, wheat and clovers.

The Umbral or siliceous limestone occurs in a vein 40 feet thick along Jacobs Creek. It is quarried here or has been and when burned makes a beautiful white lime of good quality.

EAST HUNTINGDON TOWNSHIP

East Huntingdon township lies west of Mt. Pleasant on the Fayette county line. The strata from which the soils of this township are derived range from the Waynesburg coal bed to the Freeport coal group at the top of the lower productive coal measures.

The eastern part of this township lies in the Blairsville trough and has soils derived from the same underlying strata as central Mt. Pleasant township. Sections of the great limestone outcrop on the surface of many parts of this township and enter the formation of the soil and makes splendidly rolling fertile land.

UNITY TOWNSHIP

Unity township lies north of Mt. Pleasant and has Chestnut Ridge for its eastern boundary. The outcropping strata begin with the Waynesburg sandstone and extend down to the Catskill rock. These latter do not, however, take part in the formation of the soil. The central part of this township lies in the Blairsville trough and, as in the township to the south of it, and as indicated in the strata from which the soils are derived, it contains the limestone and limy shales of the upper productive coal formation and equally as fertile and easily farmed soils as those throughout the central section of Mt. Pleasant township. At Pleasant Unity, and its vicinity in the southern part of the township is one of these fertile sections, at Latrobe, in the northern part is another, and between these towns the country is about equally fertile. The lower barren coal strata form the foot hills of Chestnut Ridge. In this hilly or more elevated section the land is usually poor, while in the lower and more moderately rolling areas the land is fairly fertile, and where the more shaly strata underly the soil, it is fertile and produces well, especially with fair agricultural treatment such as liming —which can be done cheaply here—and the application of manure and the plowing down of heavy sods.

The lower productive coal strata, along the ridge, contain some narrow sections of fertile soil adapted to fruit, potatoes, wheat and clovers already referred to. The western part of this township, lying within the lower barren formation, will be discussed in connection with Hempfield township.

DERRY TOWNSHIP

Derry township lies north of Unity along the Chestnut Ridge and has the Conemaugh River for its northern and the Loyalhanna for its southern boundary between Unity and Salem townships. The rock strata from which the soils are derived range from the Waynesburg roal bed down to the Catskill which outcrops along the Conemaugh but does not enter the formation of the soils.

The Blairsville trough from $1\frac{1}{4}$ to 3 miles wide with its upper productive coal measures continues through the central parts of this township, containing equally as fertile soils in some sections as further south except that the great limestone is very thin here and therefore not as much limestone enters the structure of these soils as further south though the limy shale strata are apparently more numerous. Along the Loyalhanna as it emerges through the gorge in Chestnut Ridge is some low land both on the barren shales and the coal measures.

This land needs underdraining to make it productive. At Latrobe this condition also prevails, and at other sections along the streams as well as along the Pennsylvania railroad from Latrobe to Blairsville. On the west side of the railroad the land is moderately rolling, with some lowland along the streams, while on the east side the foothills of Chestnut Ridge, in the barren shales begin to rise toward the side of the ridge on which most of the soil is thin and in many places rough and not easy to farm, and does not pay to farm. On the west side of the railroad the gently rolling condition of the country continues to the river and beyond into Indiana county, where as was indicated in the discussion of that county the limestone formations of the upper coal strata remain in the hills.

From Blairsville Intersection to Livermore, along the south side of the river, are some wonderfully fertile soils in the formation of which the river has taken part. These are soils especially adapted for trucking and should be used for raising these crops. Southward of these soils in the formation of which the river has played so important a part the lower barren coal shales outcrop and become the basis of the soil, and continue in a broad, moderately rolling ridge of easily farmed, apparently fertile stretch of country extending in a southwestward direction through parts of Derry, western Unity, Hempfield, western East Huntingdon and eastern South Huntingdon into Fayette county to the south. This barren coal measure district

covers a much larger area than the fertile upper productive coal section. Along the Conemaugh River the upper strata of the barren measures are exposed. These usually contain limestone or limy shales and, therefore, the soils are usually more fertile, which is the case here.

Another very good feature about these barren strata in this county is that they are shaly and the agencies of disintegration act on them readily and, therefore, deeper, smoother, more easily cultivated soils, with a greater water holding capacity are formed. What is said about these soils here is true of the entire area throughout this central part of the township.

In the western part of Derry township, in the vicinity of New Alexandria, in the Greensburg trough, the upper productive coal measures remain and the soil is formed of these strata, and while it is not as fertile as in the vicinity of Mt. Pleasant and other parts of this county, yet they are normally much more productive than the soil derived from the barren shales close by them.

In a section of these upper coal strata of 391 feet, west of Greensburg 81 feet of limestone veins occur, together with 140 feet of more or less calcareous shales. All these strata enter into the formation of the soil, throughout this outcrop of the upper coal measures, which being south of Greensburg and extends northwestward through Salem into Derry township. At Greensburg this formation is hilly, but the evidence of the fertility of the soil is everywhere present.

Northeastward from Greensburg, through Hempfield, Salem and Derry townships, the land is moderately rolling and fertile, with many outcroppings of limestone and limy shales making a fertile soil all along. The outcropping limestone and the coal veins are frequently so close together that with little handling the lime can be burned where the stone is quarried. West of this upper productive coal formation, in Hempfield, Salem and eastern Loyalhanna, the shaly barren strata again become the mineral basis of the soil.

The Loyalhanna Creek flows through this lower barren coal section of rocks into the Kiskiminetas River opposite Saltsburg. Along the river and in the vicinity where this stream flows into the river, the land is fertile and rolling on account of the action of the streams on these rather shaly formation.

South of the valley of the Loyalhanna, in the lower barren, the country becomes more hilly and the soil usually thinner, in fact this ridge which begins and extends through both Westmoreland and Fayette counties and in the former county is known as Brush Ridge but in the latter indifferently, sometimes as Grapeville Ridge, etc., is recognized as having poorer soils than the surrounding upper coal bearing strata.

These barren strata are shaly, rather easily disintegrated and, wherever the upper section of these lower barren series, which usually contain limy shales and limestone, outcrop, the soil is equally as fertile and even more fertile than where the sandy strata of the upper coal bearing series form the soils. This ridge extends from Loyalhanna through Salem, Hempfield, eastern South Huntingdon and western East Huntingdon townships.

What is said here about the fertility of the soil where the upper strata of the lower barren coal series form the soil, is true of the barren section east of Greensburg as well as west of Grapeville or Brush Ridge; and what has been indicated before is equally true that where the lower strata of this lower series of rocks form the soil, it is poorer throughout all of these townships, except where a limestone, such as the crinoidal or a limy shale, forms the underlying rock, or where the Freeport limestone of the lower coal bearing measures are brought to the surface. The ridge of barren strata can be followed from the northern to the southern end of this county by the size and type of wood growing upon them.

West of the ridge in the western part of Loyalhanna and the eastern part of Bell township, the upper coal measures again are the basis of the soil. The strata which form the basis of the soils in these two townships range from about 150 feet above the Pittsburg coal vein to about 110 feet below the Upper Freeport coal vein, so that in these two townships the lower barren coal measures are the prevailing strata.

The section of the upper coal measures, already referred to, or the beginning of the Lisbon (Irwin) synclinal or trough which enters this county between Edri and Avonmore and extends southwestward through eastern Franklin, eastern Penn, North Huntingdon, Sewickley, western South Huntingdon and Rostraver townships, makes the largest area of outcrop of the upper coal bearing and the upper barren coal strata in this county. This synclinal or trough begins on the border between Indiana and Armstrong counties—in the discussion of which counties it was refrred to. Its effects are shown in the curve of the river away from this county and a formation of a beautiful farming section with soils of such fertility that they are adapted to the most intensive farming such as a high order of market gardening or trucking.

Southwestward from this curve where the soils of these two townships are derived from the 150 feet of strata above the Pittsburg coal vein and the first 50 or 100 feet of strata immediately below this vein, are fertile and will produce all agricultural crops that thrive in this climate. Southward in Franklin township 400 feet of the upper coal bearing strata remain in this trough. Well

nigh all of the strata above the Pittsburg are shaly with none of the limestone outcrops which are so evident elsewhere occurring in this formation. The soil is loamy and easily farmed and as productive as the soils in which the limestone strata occur, showing that the limy formations are present in such forms as are available for the use of plants.

PENN TOWNSHIP

In Penn township, south of Franklin, the outcropping strata are the same as those of Franklin township and the soils very similar. These two townships are among the most fertile agricultural townships of the county. The land is moderately rolling, the soil largely loamy and deep, with large water-holding capacity, does not wash unless so depleted of organic matter that it can not hold water as it would under normal conditions. In this township, what is known as Pocono Manor, containing thousands of acres of the richest land with a forest of such magnificence probably not equalled anywhere, was located.

Here are some of the best wheat soils in the State. When this examination was made the writer saw wheat that yielded 35 bushels per acre, grown on land not any more fertile than hundreds of acres in the immediate vicinity that did not produce 20 bushels per acre. Numerous outcroppings of limestone veins and limy shales occur in these two townships.

Among the limestone, the great limestone is likely the most widely distributed. The Fishpot may also occur. Frequently the limestone and coal are so close together that the stone can be burned where it is quarried. The western sections of these two townships are in the lower barren coal bearing strata and will be discussed in connection with that section.

NORTH HUNTINGDON TOWNSHIP

North Huntingdon township lies south of Penn township, along the Allegheny county line. The outcropping strata from which the soils of the township are derived range from the Washington coal vein, in the upper barren coal series, down to 400 feet below the Pittsburg coal bed.

The strata below the Pittsburg or the strata of the lower barrens, are confined to the northwest corner of the township, while those of the upper barrens are east of the central part of the township. The soil in this township is very similar to that of Penn and Franklin, except that the area of the upper coal bearing strata is approximately twice as wide as in Penn township and therefore the area of fertile soils is larger.

The outcropping of the upper barren strata produces a small area of fairly fertile soil but even in this small section the greater fertility of the upper productive series is evident. Limestone and limy shales are plentiful throughout this township, and usually enter the formation of the soil.

SEWICKLEY TOWNSHIP

Sewickley township lies south of North Huntingdon, with the Youghiogheny River for its western boundary. The strata from which the soils are derived range from the horizon of the Washington coal seam, in the upper barren series, to about 110 feet below the Pittsburg coal bed.

Those who are acquainted with the strata included in these formations know that normally in the upper barren series from the Washington coal seam to the Waynesburg sandstone, which forms the base of the upper barrens—in a section of approximately 90 feet—there are 28 feet or about one-third solid limestone strata with an overlying disintegrated limestone of 20 feet. In a section of 437 feet of the upper productive series, 147 feet of limestone strata occur approximately all of which enter the formation of the soil.

Whether all these strata occur here is difficult to determine; but that limestone or limy shales represent these strata is certain, so that in the upper productive series, as in the upper barrens, one-third are limestone, while in the 110 feet of lower barrens, 15 feet of limestone strata occur. Disintegration has proceeded so far that in many places formation can not be located. Certainly this disintegration has not proceeded to this extent throughout the whole of the township, because the great limestone as well as some of the sandstone outcrop in a number of places, but with such underlying strata as well disintegrated as these are the soil must be fertile which is the case.

SOUTH HUNTINGDON TOWNSHIP

South Huntingdon township lies south of Sewickley with the Youghiogheny River for its western boundary. The outcropping strata range from the Lower Washington limestone, which covers several hills near the central part of the township, through the intervening sections down 150 feet below the Upper Freeport coal bed, in the eastern part of the township.

These formations include approximately a thousand feet of outcropping strata, which with many formations in this State would make a mountainous country, whereas, with these easily disintegrated strata and with the Lisbon trough and the Saltsburg anticlinal or Brush Ridge passing the former through the western part of the township and the latter across the eastern part, makes a rolling

formation, with a large acreage of soils among the most fertile in the State, adapted especially for raising such crops as corn, wheat, the clovers and hay grasses. Much of this soil is sufficiently fertile without the use of large quantities of soil amendments, for trucking and with the markets such as are right at the doors of farmers here, they should be used for this purpose.

ROSTRAVER TOWNSHIP

Rostraver township occupies the southwestern corner of the county and is separated from the township east of it by the Youghiogheny River. The outcropping strata extend from the Upper Washington limestone to the Morgantown sandstone, in the lower barren series. These latter strata outcrop only along the Monongahela River and do not enter into the structure of the soil. Along with the Monongahela and the Youghiogheny rivers are sections of alluvial soils, of splendid fertility, especially adapted to market gardening and intensive farming.

But these fertile soils are not confined to the river alluvium, but they occur in well nigh all sections of the township. At Monessen, is a small section of river alluvium, but a much larger area on the uplands extending westward from the town, of equal fertility, and adapted to just as intensive farming as the land along the river.

WASHINGTON, UPPER AND LOWER BURRELL AND ALLEGHENY TOWNSHIPS

These townships lie in the northwestern corner of the county. Washington township, with the exception of the southeastern corner where about 70 feet of the strata accompanying the Pittsburg coal bed remain, with probably some smaller sections among the hills some distance further northward, has soils derived from the underlying lower barren coal measures.

As usual, throughout this county, these strata are shaly and yield rather readily to the agencies of disintegration so that the soils are deep, the hills rounded, do not wash so readily and produce with good agricultural treatment as large crops as grow on the best lower barren soils. The rotation is grass, corn, oats and wheat, wheat being raised more to get a good stand of grass than for the wheat. This is poor practice. Surely wheat could be made a paying crop.

The soil of this and all these northwestern townships produce splendid sods, and by plowing down a good heavy sod every four or five years and by raising a few short season crops for humus and by the use of a little lime and commercial fertilizer, wheat or any other crop can be made to yield paying returns.

Upper and Lower Burrell and Allegheny townships lie northwest of Washington. At Vandergrift, what is known as the Waynesburg trough or synclinal, enters Allegheny township and forms the curve in the river and the fertile farming land in the vicinity of that town, and from there southwestward a few areas of the Pittsburg coal vein with its accompanying strata form a more fertile soil than that of the surrounding barren formation. Northwestward from this part of these townships only the lower barrens form the soil sections which are very hilly and some sandy. At Hyde Park, in the curve of the river, which is likely caused by the Nineveh trough or synclinal, above Leechburg is a section of fertile soils adapted to intensive farming.

On the hills west of Leechburg several peach orchards have been started which, at the time this examination was made, looked thrifty and promising. The soil from all appearances is certainly adapted to fruit raising. From Hyde Park northward the country is hilly and some of it not adapted to farming, all of which should be reforested. At New Kensington and Arnold in the curve of the river is a rolling country well adapted for the hay grasses.

Some good farming is done throughout this northwestern section, as in such places as west of Leechburg, on the hills, where farming operations upon the lower barren coal shales yield returns from 100 to 150 acres of more than $2,500. If this can be done here than what could not be done with the magnificent fertile soils of so many sections of the county.

FAYETTE COUNTY

Fayette county was erected out of Westmoreland county by an Act of the Assembly, September 13, 1783. The burning of Hannastown, July 13, 1782, led to the erection of Fayette. It contains 508,800 acres, of which 318,475 acres is land in farms, and of which 211,519 acres is improved farm land. 22,736 acres were planted in corn in 1909, yielding 717,620 bushels; 15,130 acres were sown in oats, yielding 371,325 bushels; 13,248 acres were sown in wheat, yielding 186,944 bushels; 3,409 acres were sown in buckwheat, yielding 66,409 bushels; 690 acres were sown in rye, yielding 8,749 bushels; 2,113 acres were planted with potatoes, yielding 163,964 bushels; 2 acres were planted with tobacco, yielding 1,350 pounds; 39,300 acres were sown with all forage crops, yielding 41,577 tons of various kinds of hay. Of the 211,519 acres of improved farm land, 96,628 were used for raising farm crops, while 114,891 were not so

used and were likely producing weeds. At this time Fayette county had a population of 167,449 to feed, 19,852 cattle, 8,395 horses, 253 mules, 15,562 swine and 10,448 sheep.

SOIL FORMATION

The geological formations outcropping in this county from which the soils are derived, are the Catskill, the Pocono sand, Mauch Chunk red shale, the Pottsville conglomerate, the Upper Freeport bed and lower coal measures. The lower barren formations, the Pittsburg coal measures and the upper barren coal measures also containing the following limestone formation: The Waynesburg limestone, 20 feet, the Uniontown limestone, 12 feet, Great Limestone, 80 feet, Fishport limestone, 25 feet, Redstone limestone, 10 feet, making a total of 147 feet of limestone in this county. Most of it is available for making agricultural lime wherever this may be needed.

This county can be divided into three sections which will include all the rock and soil formations. Beginning with the southwestern corner, in Henry Clay township, Laurel Ridge enters the county from West Virginia, and approximately forms the county line between Fayette and Somerset, northward to the line of Westmoreland county. Next, follows the southern extension of the Ligonier Valley, then Chestnut Ridge with very similar soils, derived from similar rock strata as Laurel Ridge, thence westward to the Monongahela River follow successively the lower carboniferous rocks, the conglomerates, the lower productive coal rocks along Chestnut Ridge, then the lower barren series, the upper productive coal bearing and the upper barren rocks which form the soils between the base of this ridge and the Monongahela River.

HENRY CLAY TOWNSHIP

Henry Clay township occupies the southeastern corner of the county, with the Maryland line for its southern, and the Youghiogheny River, which forms the Somerset county line, for its eastern boundary. The strata from which the soils of this township are derived, range from the shales connected with the Philson coal bed, above the Mahoning sandstone, which outcrops on the National Pike at the western line of the township, through the lower productive coal measures, the conglomerates, the Mauch Chunk red shale, into the Catskill, along the Youghiougheny River. Along the National Pike and some distance north of it, and extending south into West Virginia and Maryland, are the glade lands, formed of the strata of the underlying rock, largely the lower productive coal measures moderately rolling and productive, having an elevation of 2,200 feet above tide with a delightful summer climate, but winters of extreme cold. This land produces the hay grasses and among the grains rye, oats,

buckwheat and among the clovers red mammoth, and alsike and the summer clover Canada field peas. The loamy, gravelly and sandy soils are well adapted for potatoes. It seems that a rotation of clover, potatoes and rye should make profitable returns here. Northward from the glade lands the country becomes rugged and farming except on elevated land, such as occurs along the Youghiogheny and the highland divides of the streams, is attended with difficulties.

WHARTON TOWNSHIP

Wharton township lies west of Henry Clay, with the West Virginia line for its southern boundary. The strata, forming the soils of this township, extend from the middle of the lower barren coal series to the Catskill along Mill Run in Chestnut Ridge. The southeastern and partly the southern parts of this township are in the glade lands, discussed in Henry Clay, and have similar adaptations. This township extends along Chestnut Ridge for about sixteen miles. Along this whole distance, the land is rocky, stony and hilly and, in same places, mountainous. The mountain or Mauch Chunk red shale limestone, and the silicious limestone occur along this ridge, the former at such places as Chenys Run where is has been quarried as a furnace flux and also burned for lime. The coal and limestone are usually close together and the lime can be burned at small expense. Several Divides occur throughout this township upon which some broad rolling land occurs but the difficulty of getting farm products to market from these highlands is not easily overcome. The farming soils of the township are derived from the lower coal bearing rock and the conglomerates. From Uniontown along the National Pike, in crossing Chestnut Ridge, one passes over the lower rock outcropping on this ridge into the Ligonier Valley, to Chalk Ridge, a limestone formation of great value to this section. From this place east and south is the farming land of this township. At such places as Farmington, where a moderately rolling upland country, with soils derived from limy shales and outcropping limestone rocks, has for years sustained a thrifty agricultural community.

From Farmington, north to Meadow Run and south on the uplands of Little Sandy and Big Sandy creeks, are stretches of naturally fertile farming soils adapted for growing all agricultural crops that will thrive in this climate. These upland soils will produce elegant sods and are well adapted for pasturing and with the limestone easily accessible, these blue grass sods can be maintained for years unless pastured too hard. This in connection with fruit such as apples could be made a splendid fruit and stock section, as sheep for the rougher lands and horses and cattle for the hilly formations. Such an operation should be encouraged as much as possible in this section.

STEWART TOWNSHIP

Stewart township lies north of Henry Clay and Wharton, with the Somerset county line for its eastern boundary. The strata extends from 500 feet above the Upper Freeport coal bed down to Devonian strata along the Youghiogheny River. A series of rounded knobs, extending from the Conemaugh to the National Road, raise the lower outcropping strata in many places to the top of these knobs. Sugar Loaf Mountain, in this township is one of these knobs, and near the top of this knob, the mountain limestone outcrops. An examination of this knob revealed the wonderful influence of limestone and limy formations of the underlying strata on the soil. Around the mountain, where the limestone occurs, is a terrace of splendid soil, some of which is farmed, part of it in forest. The forest is composed of the various kinds of oaks, while that growing in the valley is composed of the soft woods. Throughout this whole section, wherever the limy shales and limestone enter into the composition of the soil, there the oaks prevail and where the sandy strata compose it there the beech, birch and maple make up the forest. A considerable acreage of the hills south of the Youghiogheny and west of Sugar Loaf Mountain were planted with apples a number of years ago, a large number of these trees still look thrifty and are bearing without cultivation, spraying or pruning. It seems that the intermixture of soils made of the coal strata, the conglomerates, the Mauch Chunk red shale is conducive to wood and fruit growth as the forests and orchards throughout this section still indicate.

Eastern Dunbar, northern Stewart, Springfield and Saltlick townships have all similar strata as those already discussed, with very similar soils. At Ohiopyle, in Stewart township, at the Falls of Youghiogheny, is a narrow farming section very characteristic of many such sections along the streams. Along the road between Springfield and Connellsville on the east side of the mountain is a rolling upland section probably the best that is found in Springfield township, with soils formed of the lower productive coal measures, and characteristic of others smaller in size.

GEORGES AND SPRINGHILL TOWNSHIPS

These townships, in the southwestern section of the county have soils derived from similar rock strata, beginning with the rocks of the Sewickley coal bed and extending down to the serpentine, the former or the upper productive rocks are confined to the highlands of central and western Springhill, and western Georges, while the latter are exposed in the deeper ravines of the streams flowing

from Chestnut Hill and on the crest of the ridges. In this township (Springhill) a large part of the slope of Chestnut Hill is less steep and rugged than farther north and consequently these hillsides are being farmed at a higher elevation than in any other part of the county. These soils produce well, especially are they adapted for apple raising, and a large acreage should be planted with this fruit. Rye, oats, corn, wheat, potatoes and the grasses also produce well. The swiftly changing formation from the crest of the hills to the coal measure rocks within the limits of a few miles produces soils not equalled for numbers in rocky structure anywhere in the State and of splendid agricultural capacity. The soils in the central and western part of this township on the higher elevations—geologically—were largely derived from the disintegration of the lower division of the Great Limestone and its accompanying strata overlying the Sewickley coal bed, and where this coal bed is carried away by those underlying it which includes, all but the southern part on Cheat River the land is fertile.

These soils are productive, and where not too hilly, well adapted for farming. They will produce the regular agricultural crops, and have done this for years without the care they should have had and if treated well will yield large returns continuously because of their composition and structure. The barren measure soils along the side of Chestnut Ridge, already referred to, are stronger here than any part of this county, which is largely true of the soils of this formation along George's Creek and Cheat River, because in the latter case they have been benefitted by the disintegration of the rocks overlying them and in the former by the intermingling of a number of formations.

Georges township lies north of Springhill, and the crest of Chestnut Ridge forms its eastern boundary. The rock exposures from which the soils of this township are derived range from the Waynesburg coal bed to the serpentine formation along Chestnut Ridge. The formation here is more hilly and less adapted for regular farming, but it seems that on the less stony and rocky land, apples would do well from the appearance of the few orchards visited at Fairchance. Southward to Hayden on the lower coal measures and the lower barren rocks, the high lands are usually productive while some of the lowlands to make them productive need underdraining, but in many places produce good hay crops without this, but do not produce the cereal crops so well. Such soils occur in the vicinity of Fairchance. The central and western section of this township is covered by the upper coal rocks, and between the Uniontown and Sewickley coal beds, five limestone deposits varying from one to ten feet in thickness and having a total thickness of

twenty-five feet occur. These formations are easily disintegrated and as is evident from their composition produce a splendid agricultural soil of moderately rolling character, easily farmed.

SOUTH AND NORTH UNION TOWNSHIPS

South Union township lies north of Georges township, with the National Road for the eastern boundary. The rock strata outcropping in this township, from which the soils are derived, range from the Catskill which come to the surface in Chestnut Ridge east of Monroe up to the Waynesburg coal strata which cover the central and western section of the township. In going from Uniontown along the National Road up Chestnut Ridge, all these formations, down to the Catskill, are passed over before the eastern boundary of the township is reached. This gives some idea of the formations entering the soils in this section. These soils produce wood, in some sections, so dense in growth that further increase is not a question of fertility but of sunlight.

Along the National Road, east of Monroe, on the lower and less steeply hilly, and on some of the more hilly parts, orchards have been started which look thrifty and seem to bear well in spite of little care in the way of spraying, pruning or fertilizing, given them. It seems that apple raising could be made a success in soils derived from the numerous intermingling strata of limestone, sandstone, and shales. In the vicinity of Monroe is a broad valley on the barren rocks, moderately rolling, some of it low and spouty and needs draining. The soils of the central and western section of this township are derived from the disintegrated rocks of the upper coal measures containing seven limestone veins. The soils are fertile and among the most productive in the State. All agricultural crops will yield well here. The soils are easily farmed being largely loams with some gravels and clays.

North Union is very similar to South Union township, the outcropping rock strata from which the soils are derived extending like South Union from the Waynesburg coal bed to Catskill rock. In addition to what has been said in regard to the soils of the central and western sections of South Union township, it may justly be added, that for productive capacity, the moderately and gently rolling soils north, east, south and west of Uniontown, with equally good treatment, are not excelled anywhere in the State. The soils along Chestnut Ridge are very similar to those already discussed in South Union township.

DUNBAR TOWNSHIP

This township lies north of North Union and has the Youghiogheny River for its northern boundary. The western section of the township, from the town of Dunbar or Dunbar Creek westward, is similar

to both the Union townships, having some of the gently rolling fertile and more hilly soils. At Dunbar along Dunbar Creek the land derived from the intermingling of the rocks of the barren shales and the upper coal formations are fertile. Near Mt. Braddock, which is a hilly formation, extending from North Union into Dunbar township, throughout this formation limestone and limy shales make the soils, though in many places hilly, they are very productive. The eastern section of Dunbar township includes the Chestnut Hill region into the Ligonier Valley within about four miles of Ohiopyle, in Stewart township. The western section of this ridge is very similar to the same sections further south and, therefore, needs no further discussion here.

CONNELLSVILLE TOWNSHIP

This township has the Youghiogheny River for its southern and the crest of Chestnut Ridge for its eastern boundary. The rock strata from which the soils are derived extend from those above the Pittsburg coal bed to the Catskill rocks in the gap of the river. The Pocono sandstone form the cliffs along the ridge below the Umbral limestone takes part in the formation of the soils. The country is rough and hilly and not much of it adapted to farming. The central section, north of Connellsville is gently rolling but becomes more hilly northward along the lower coal bearing and the lower barren rocks. Three limestone veins outcrop near Connellsville where the Pittsburg coal vein remains all of which enter into the formation of the soil. This formation extends to the western section of the township producing equally fertile soils.

BULLSKIN TOWNSHIP

Bullskin township has, for its eastern boundary, the crest of Chestnut Ridge and extends west to Westmoreland county, with Jacob's Creek forming part of the western boundary. The soil formations along Chestnut Ridge are very similar and adapted for similar crops as those already described. The formation of the western section extend from the lower coal measure rocks to above the Pittsburg coal vein and include the formations and soils similar to Connellsville township.

TYRONE TOWNSHIP

Tyrone township occupies the territory between the Youghiogheny River and the Westmoreland county line, west of Bullskin and Connellsville townships. The rock strata outcropping in this township extend from 200 feet above the Pittsburg or upper coal bed to the Lower Freeport coal seam in the lower coal bearing strata. The upper coal bearing strata cover the eastern section of the township and form the soils, which are equally as fertile as those

south of the river already described. Along the river, at Connellsville, both on the north and south sides, especially in the great bend the stream make here, are alluvial soils of superior fertility on which large market garden crops could be raised to supply the markets of this vicinity, which are not equalled anywhere in the world. The outcropping rock strata of western Tyrone, eastern Perry, nearly all of Franklin, western North Union, eastern Menallen, eastern German and eastern Nicholas townships belong to the lower barren formation and, therefore, the soils of this district extending from Jacob's Creek, the northern boundary of this county to and beyond the West Virginia line are derived from these strata.

Beginning in Tyrone township, west of Dawson, the lower barren strata make the soils of this township to its northern and western extremity and they reach the greatest width in this part of the county on Jacob's Creek. From his creek southward the strip of these rocks narrows until in Nicholson township, it is comparatively very narrow. From all the observations that it was possible to make along this line of outcropping rocks of these lower barren strata show, that they disintegrated more readily, which is evident from the more rounded and less steep hillsides throughout the district and the deeper soils. These soils will produce sods of blue grass which, if cared for, can be maintained for a long time especially if limed occasionally. Not only will these soils maintain sods but they will produce potatoes, rye, oats, corn, buckwheat, grass and wheat, if limed. Early market crops can be raised on the more sandy of these soils and are being raised now. Apples, peaches and small fruits will do well in the higher elevations of which there are many. The soils of Washington township in the northwestern corner of the county and those of Jefferson south of it, and those of Redstone, south of Jefferson and those of Luzerne west of Redstone and those of western Menallen, south of Redstone and those of western German south of Redstone are all derived from the upper coal bearing rocks except a section of upper barren rocks extending from west of Fayette City, in Washington township, to beyond Brown's Run in German township. From the West Virginia line along the Monongahela River immediately above the river hills as well as along the river valley where in many places, alluvial soils of great fertility are formed, the soils are fertile being derived from the rocks of the upper coal measure which contain more limestone strata than any of the formations of this district.

WASHINGTON TOWNSHIP

Washington township lies entirely within the upper coal bearing rock formations. East, north and south of Fayette City, in this township, the land is rolling and fertile, being derived from the

disintegration of the shales, sandstone and limestone of the upper coal bearing rocks, among the latter of which this township contains the lower division of the great limestone, the Waynesburg limestone. The eastern section of this and the western part of Perry townships are equally fertile and the land is rolling and the majority easily farmed and will produce magnificent crops.

JEFFERSON TOWNSHIP

Jefferson township has the same formations as Washington, except that a larger section of the upper barren coal measure rocks, beginning with the Washington coal bed, remain in this township than in Washington and these take part in the soil formation. The whole of the rock strata exposed extends from 50 feet below the Pittsburg coal bed so that in the formation of the soils of this township about 30 feet of the upper barren coal measure limestone and about all of the upper or Pittsburg coal bed limestone among which the lower division of the great limestone is 90 feet thick and the Freeport, 30 feet, outcrop along the Monongahela River. The country is hilly but in the limestone formations all crops thrive. The sandy and shaly soils can be kept in good condition in such an environment.

BROWNSVILLE AND LUZERNE TOWNSHIPS

A sandy shale and sandstone known as the Waynesburg sandstone is the basis of a considerable section of soil in the vicinity of Brownsville, but these soils are not as lean as the soils formed entirely of the lower barren measure rocks. This section is hilly especially along the river and some distance east, but among the uplands from which the small streams rise here the land is rolling, fertile and will produce well all kinds of crops adapted to the climate. At Hopegood, which is likely in Luzerne township, the land is gently rolling and some places likely too wet but could easily be drained and then would be the most productive soil. At Merrittstown in Luzerne township, the soils are fertile though some of the hills are sandy. The outcropping rock strata from which the soils of these two townships are derived range from the sands and shales above the Washington coal bed to about 30 feet below the Pittsburg coal formation and like Jefferson township, the soils are fertile.

REDSTONE TOWNSHIP

This township contains the largest section of the upper barren rocks in the county ranging from 400 feet above the Waynesburg coal bed to 30 feet below the Pittsburg in the lower productive strata. Limestone (1a) of this upper formation which occurs in the hills in the vicinity of Merrittstown and east of Brownsville occurs

here along the National Road, near the western boundary of the township, and from here southward its salient effects are seen in the fertility of the soils of these hills.

Much of this country is hilly, but because of their productive capacity, these soils should be farmed, and such crops produced that only the minimum amount of fertility is removed. At many other places moderately rolling and equally and some more fertile soils exist where all agricultural operations are possible and where markets exist such as do here farming should be developed to the highest degree of perfection.

GERMAN AND MENALLEN TOWNSHIPS.

The strata from which the soils of this district are derived range from about 100 feet above the Washington to 20 feet below the Pittsburg coal vein. t such places, at Rothrock, Upper Middletown, Waltersburg, north and south of these places the soils are derived from the Pittsburg coal measure rocks and are fertile, all along to New Salem, in southern Menallen township, as far south as Masontown, in German township. Westward the same conditions prevail except that in some of the upper barren formations are soils that are more sandy through here than elsewhere.

Fayette county with a large acreage of naturally fertile soils and a still larger acreage of soils, that can, with good agricultural methods, be made fertile and with soils with natural adaptations, for special types of farming, such as the apple soils, on the Laurel and Chestnut ridges, the clover and alfalfa soils of the Pittsburg coal seam horizon and the river bottom for trucking and with blue grass that will make better, finer and larger quantities of wool, such as can only be raised in the neighboring counties, with fruit possibilities, dairying, trucking, grain raising, wool producing and with markets for these and many more, the most intensive farming should be practiced at once, before these markets disappear.

WASHINGTON COUNTY

The Act of the Legislature of Pennsylvania under date of March 28, 1781, gave Washington county its boundary. It contains 551,680 acres, of which 503,923 acres is land in farms, and of which 432,001 is improved farm land. 36,625 acres were planted with corn in 1909, yielding 1,666,881 bushels; 28,705 acres were sown with oats, yielding 788,882 bushels; 25,125 acres were sown with wheat, yielding 409,111 bushels; 103 acres were sown with buckwheat, yielding 1,699

bushels; 257 acres were sown with rye, yielding 3,356 bushels; 3,128 acres were planted with potatoes, yielding 297,090 bushels; 88,693 acres were sown with all forage crops, yielding 106,964 tons of the various kinds of hay. Of the 432,001 acres of improved farm land, 182,636 were used for raising farm crops, while 249,375 were not so used and were likely producing weeds. At this time Washington county had a population of 143,680 to feed, 42,918 cattle, 15,596 horses, 236 mules, 27,025 swine and 196,005 sheep.

Washington county lies west of Allegheny and Fayette counties, north of Greene, on the boundary line between Pennsylvania and West Virginia. The outcropping geological strata, which forms the basis of the soils of this county, begin with the lower barren coal measures in the northwestern part and along some of the streams, and range up through the Pittsburg and upper coal measures, which cover largely the central and eastern part of the county, into the upper barren strata, which extend over the southern and southwestern section. The U. S. Geological Survey places the county into the Monongahela and Dunkard formations.

The drainage of the county, with the Monongahela River forming the eastern boundary and the Ohio River just beyond the Panhandle, belonging to the State of West Virginia, is accomplished by a large number of small streams flowing into these rivers. Ten Mile Creek forms part of the boundary between this and Greene county and drains a large number of the southern townships of the county. Chartiers Creek rises in the central part of the county and flows north through Allegheny county, into the Ohio River and drains central Washington and southern Allegheny county.

A large number of small streams drain the county between this and Ten Mile Creek on the south, while branches of Raccoon Creek drain the county further northwestward. Hermans Creek, Cross Creek, Buffalo Creek and Robinson Fork, with a number of smaller streams between them, drain the western part of the county.

The lowest rock, geologically, that comes to the surface in this county, are the lower barren coal measures in the northwestern part of the county. These strata extend from the base of the Mahoning sandstone to the base of the Pittsburg coal vein, containing only a few inferior limestone and limy shale strata. The upper productive coal strata extend from the base of the Pittsburg coal vein to the Waynesburg sandstone, containing an enormous mass of limestone and limy shale strata. This formation covers a large section of the central and eastern sections of the county. The upper barren coal strata, as already indicated, cover the southern section of the county, and contains all the strata above the Waynesburg sandstone. In this series of rock, are numerous limestone deposits.

Limestone, which in many localities, especially in this county, attain extraordinary thickness. With this explanation the discussion of the townships will be more readily understood.

HANOVER TOWNSHIP

This township occupies the northwestern part of the county, on the Ohio State and Beaver county lines. The strata outcropping in the township and forming the basis of the soils, range from 300 feet below the Pittsburg coal vein to the Great Limestone about 115 feet above it. This township has, therefore, a larger territory of lower barren strata than of the upper coal series.

The ridge forming the Divide between Raccoon and Wheeling Creeks holds the Pittsburg coal and the Great Limestone and forms fertile soils. The land is more hilly than normal in Washington county throughout this township but most of it can be farmed profitably.

The barren strata under the Pittsburg coal vein contains limestone or limy shales where the limestone strata should be located. This is also true of the Ames (crinoidal) limestone formation, and, therefore, the hills are more rounded because disintegration has proceeded further than is usual in the barren rock, and consequently the soil is more fertile. These soils are loams, gravels, some sandy and some clays

ROBESON TOWNSHIP

Robeson township lies southeast of Hanover, along the Allegheny county line, with Robeson Run for its southern boundary. The geological strata exposed in the township are the same as those of Hanover, already discussed. The northern section of the township, along the Beaver county line is in the lower barren formation; but even here, in some of the higher elevations, the beneficent effects of the Great Limestone are manifest in less stony, more gently rolling and fertile soils, adapted especially, the loamy and gravelly types, for raising potatoes, wheat and clovers, or early market crops. The valleys are formed of the barren strata and where the limy shales or limestone, such as the Ames (crinoidal) does not occur, the soil is not naturally fertile, as fertility goes in Washington county, but these soils can be made productive. The central and southern section of the township is within the upper coal formation and the soils are naturally fertile, adapted to the raising of all agricultural crops.

Some methods of hilly land farming are necessary in some sections, at such places as Midway, where a sandy formation prevails on the lower hills and the land washes more readily. Bluegrass thrives here.

SMITH TOWNSHIP

Smith township lies southwest of Robeson and south of Hanover. The outcropping rock strata extend from about 100 feet below the Pittsburg coal vein to the Washington Upper or No. 6 Limestone in the upper barren coal strata. Nearly the whole of the township is covered with the upper productive coal formation, except a narrow strip along Raccoon Creek, which is in the lower barren formation, and a section in the southern part in the upper barren series.

From Burgettstown northward, on the road to Florence, the land is fertile except along the creek where the hills are steep and rocky and where the lower barren strata outcrop and form the soil. From Burgettstown southward, eastward and westward the Pittsburg or upper productive coal strata cover the township. In one exposure of strata along the Burgettstown road of 200 feet 85 feet of limestone and limy shaley strata occurs. All these limestone strata enter into the formation of the soil in many sections of the township, because 80 feet of them are above the Pittsburg coal vein, and as already indicated, this coal vein is near the base of the strata in this township. The land is moderately rolling, easily farmed and very productive.

JEFFERSON TOWNSHIP

Jefferson township lies west of Smith and south of Hanover. The strata from which its soils are derived range from about 200 feet below the Pittsburg coal vein, in the barren formation, to the middle Washington limestone or Limestone No. 4. This limestone occurs on the highlands along the Burgettstown and Eldersville road, but it is shaly and not as thick as in other sections of this and Greene county.

This township is hilly, the strata as a rule are more sandy and not as easily disintegrated, therefore, the hills are higher and the limy shales and the limestone strata are thinner. The Great Limestone which, with the shales it contains, is, in some places, 173 feet in thickness, is here only about 14 feet thick. These changes of strata produce changes in the configuration as well as in the fertility of the land. These soils are adapted for fruit, apples and peaches will thrive here.

CROSS CREEK TOWNSHIP

Cross Creek township lies southeast of Jefferson and southwest of Smith township. The strata from which the soils are derived range from the Pittsburg coal vein, which outcrops on Cross Creek, in the southwestern corner of the township to the upper Washington limestone No. 6 which remains in a number of places on the hills in the northeastern part of the township. Along the western branch

of Cross Creek, coming in from Jefferson township, the land is more hilly, especially along the creek, but not enough so as to interfere with successful farming. In this township the limestone or limy shale strata, immediately above the Pittsburg coal vein as well as the limestone and limy shale strata higher up enter the formation of the soil. Some of these limestone and limy shale formations immediately underlying the soil have disintegrated to such an extent, though retaining their stratified formation, that they can be spaded with a shovel. In this examination a number of places were visited where it was possible to spade up these disintegrated limestone and limy shale and examine them chemically. One of the specimens of this disintegrated limestone contained over 20 per cent. carbonate of lime.

On the Divide between the branches of Cross Creek, on which the village of Cross Creek is situated, limy formations outcrop and make very fertile soil. Immediately west and northwest of the town the Great Limestone outcrops on the hills and is conspicuous. From it the soils of these hills are largely derived and consequently are very fertile. White oak trees of enormous size still remain here, relics of a forest that at one time covered the hills and valleys of this entire section, as well as many other parts of this county.

The soils of this township produce magnificent bluegrass pasture. One field that was especially visited, and likely there are many others, has been in blue grass for 54 years and was pastured every year during that time and at this time had as rich a pasture as at any previous time. Another field visited has been in pasture since 1864 and was pastured every year since that time, and with animals pasturing on it at the time of this inspection, had bluegrass knee high. These instances are given to demonstrate the fertility of the soils in these limy formations. Bluegrass does not grow as prolific in the sandy formations unless they contain lime.

Wheat, corn, the clovers, especially alfalfa, thrive here. Potatoes do well, especially on the more gravelly soils. The soils range from clays to stony loams. These are agricultural soils. Intensive farming should be practiced here in its highest developed conditions.

MT. PLEASANT TOWNSHIP

Mount Pleasant township lies east of Cross Creek and Smith and south of Robeson. The strata extends upward from the Pittsburg coal bed to Limestone No. 6; the former outcrops near the Chartiers township line on a branch of the Chartiers Creek, while the latter remains only on the highest hills in the vicinity of Hickory.

Going on the McConnellsville Road to Hickory, a short distance from the Chartiers line, the Great Limestone outcrops and enters the formation of the soil. The Great Limestone occurs again west of

Hickory and along the branches of Raccoon Creek in the northwestern section of the township, everywhere entering into the formation of the soil. In this northwestern section, the land is hilly, but fertile. Some limy formations above the Great Limestone occur here. At Hickory the land is moderately rolling and fertile, adapted to the raising of all agricultural crops. The Divide between Chartiers Creek on the east and Raccoon and Cross creeks on the west passes approximately north and south through the central part of the township and forms a more rolling section of upland soil of splendid agriculture capacity.

CECIL, CHARTIERS AND PETERS TOWNSHIPS

Cecil township lies east of Mount Pleasant, Chartiers southeast and Peters lies east of Cecil. The strata that enter the formations of the soils of these townships are so similar that they can be discussed together. In Cecil township, the strata from which the soils are derived, range from the Great Limestone to the Washington coal bed, in Chartiers and Peters townships, from the Pittsburg coal vein in the former to the Waynesburg, in the latter to the Washington coal vein. The Great Limestone as much as 50 feet in thickness outcrops along about all the streams in Cecil township and it, together with the limy shales that occur with it, enter very largely into the formation of the soil of this township. Fragments of Limestone No. 2 of the upper barren measures remain on the hills in some places as near Venice and forms a fertile soil. The land is nicely rolling easily farmed and fertile. All agricultural and truck crops can be raised in most sections of this township. Some of the soils are sufficiently sandy for raising early truck crops. In the vicinity of Greens Station are such soils.

The greater part of this township should be devoted to the dairy industry, because land that may be sandy and hilly and may wash readily is sufficiently limy to produce bluegrass pasture, while every two acres of the more rolling improved land will produce sufficient crops to keep one cow for a year. Such a proposition should be inviting as close to all markets as this township is.

CHARTIERS TOWNSHIP

Chartiers township lies south of Cecil, with Chartiers Creek for its eastern boundary. Disintegration of the limy shales, limestones and shaly sandstone in the vicinity of the Great Limestone, from which these upper productive coal soils are largely derived, have been so completely disintegrated that about the whole township has become a gently rolling formation of the highest type of soils in the county, or for that matter any other county in the State.

The Waynesburg coal appears only in the highest elevations, and as there are few of these, there are only a few sections which catch the sandstone underlying it and, therefore, there are only small areas of sandy soils. The soils are largely clays, what might be termed stony clays, because rather frequently sandstones, the harder shales and the more difficulty disintegrated limestone are mixed with the soil in profusion and make them stony clays and loams.

What has been said of the capacity of the soil of Cecil township, applies with greater force in this township, because, with few exceptions, the most intensive farming can and should be practiced in this entire township.

PETERS TOWNSHIP

The soil of this township, though including the same strata as the other two townships discussed, are not as fertile, because, evidently harder and less easily disintegrated sandy formation occur. The land is more hilly. The hills are steeper and farming more difficult, but not more difficult than in many of the townships of the county. The land produces well. The townships along the Monongahela River, the soils of which are derived from similar strata, beginning with the north, are Union, which occupies the northeastern corner of the county, Carroll, Fallowfield, Allen, East Pike, and part of West Pike and East Bethlehem which occupies the southeastern corner of the county.

The strata entering the formation of the soils of Union township begin with the limestone underlying the Washington coal seam, which outcrops along the northeastern and northwestern sections of the township and extends approximately 100 feet below the Pittsburg coal bed at several points along the river. The land in this township is not as hilly as that formed of the sandy strata in other sections because disintegration and leveling effects have been able to proceed further. The soils are fertile except where too much sand has been mixed with them as is the case in several sections near Finleyville where considerable washing has occurred which, in comparison with other sections shows that the soil is light but by no means poor. The land here is rolling and can be farmed easily. Along the river the hills are usually too steep for farming except where the river curves away from the county there are alluvial and deluvial soils of splendid fertility, adapted for the raising of trucking crops, for which little of this soil is used at this time.

CARROLL TOWNSHIP

Carroll township lies south of Union. The strata exposed in this township range from 180 feet below the Pittsburg coal bed up to the Waynesburg coal seam. As above stated, at Monongahela City, in the curve of the river, away from the county, is a beautifully rolling section of fertile soil adapted for raising all kinds of agricultural crops. The larger part of this land is within the domain of the city. On the elevations west of the city the land is hilly and cut down into by the little streams that flow into Pigeon Creek and the Monongahela River from a small Divide on the uplands which are rolling. Where the river curves back into the county, the river hills are steep. On the highland of this curve is some fairly fertile farming land. At Monessen, in Westmoreland county, where the river curves away from that county, is a similar formation to that at Monongahela City.

FALLOWFIELD TOWNSHIP

Fallowfield township lies south of Carroll. The strata begin 160 feet below the Pittsburg coal vein and extends up to the Washington coal bed. It must be remembered in these discussions, that the strata beneath the Pittsburg coal invariably do not enter into the structure of the soil along the river. Immediately south of the line between Carroll and Fallowfield townships the river again begins to curve away from the county, and at Charleroi, another of the fertile rolling sections occur, adapted to the raising of all agricultural crops. The soils of this township are, as a rule, constructed of rich strata. In one section on Pigeon Creek, of 270 feet of strata, 80 feet of limestone and limy shales occur, with only 25 feet of massive sandstone, consequently disintegration has even on highland proceeded further than usual. On the Divide between the river and Pigeon Creek are some splendid rolling sections of fertile soil.

ALLEN TOWNSHIP

Allen township lies southeast and east of Fallowfield and east of Pike township. The strata that enter the formation of the soil extend from the Pittsburg coal vein to the Waynesburg in the upper barren coal series. In the northeastern part of this township the curve in the river, referred to in Fallowfield, is continued, and at Bellevernon and Allenport are some of the alluvial and deluvial soils already referred to. A sandy formation in a terrace 180 feet above the river occurs here which, however, does not materially effect the soil. The central part of this township is hilly, while the western part above the small streams is more rolling.

EAST PIKE RUN TOWNSHIP

This lies southwest of Allen. The strata entering the formation of the soil extend from the Pittsburg coal vein to 150 feet above the Washington coal, in the upper barren coal formation. This is a hilly township and much of the land too steep for profitable farming operations except in the northern part and along the western side and in West Pike Run township where some rolling land occurs of good fertility easily farmed.

EAST BETHLEHEM TOWNSHIP

East Bethlehem township occupies the southeastern corner of the county. The outcropping strata range from about 80 feet below the Pittsburg coal vein to the Waynesburg sandstone, the upper member of the upper productive coal measures. From West Brownsville, along the river, the hills are steep, and in many places this condition prevails for some distance back of the river, as at Centreville Station, where this hilly formation extends westward of the river for as much as two miles.

From West Brownsville to Centreville, along the National Pike, above the river hills, are some splendidly rolling farming soils, very fertile and easily farmed. The more hilly parts should be kept in pasture, because some of these soils are inclined to wash, or hillside farming should be done. In the vicinity of Centreville are limy shales and, consequently, fertile soils. From the elevations above the Pittsburg coal vein and from the examination of the soil, it is evident that the Great Limestone and its accompanying strata enter very largely into the formation of the soil which is the reason for these soils being so productive. Several terraces exist here similar to those of Bellevernon, but from all that could be observed, they do not materially effect the composition of the soil. All agricultural crops thrive here.

Somerset, Nottingham, North and South Straban, Canton, Hopewell, Independence, Donegal and Buffalo townships have soils derived from similar strata.

SOMERSET TOWNSHIP

Somerset township lies west of Fallowfield and Carroll. The rock strata from which the soils of this township are derived extend from 150 feet below the Waynesburg coal seam to the Upper Washington limestone. Approximately all of these strata are in the upper barren coal measures except about 100 feet. The Great Limestone does not come into the structure of the soil. The strata that do form it are about equally divided into sandstones, sandy shales and limestone. In the townships previously discussed, the Great Limestone takes part in the formation of the soil. The Upper Wash-

ington limestone remains on the upland of Pigeon Creek. Including this limestone of all the limestone, sandstone, shaly sandstone and coal seams that normally enter the formation are present here and there are down to the Waynesburg sandstone 100 feet of limestone strata in a formation of about 300 feet. A soil formed of one-third limestone has a basis of fertility not frequently equalled. Some of this land is hilly and where the sandstone predominates the soils are inclined to wash but they contain sufficient lime to produce blue grass and should be maintained in sod or hillside farming should be practiced. These soils will produce all agricultural crops.

NOTTINGHAM TOWNSHIP

Nottingham township lies north of Somerset and west of Union. The strata which form the basis of the soils begin with the Pittsburg coal bed and extend to the Upper Washington Limestone No. 6. The Great Limestone takes some part in the formation of the soils of this township and so does the Waynesburg sandstone enter partly into the formation and make some sandy soils along its horizon, otherwise the soil is very similar to that of Somerset township. A small Divide between Mingo, Peters and a branch of Chartiers creeks passes through this township and forms some rolling fertile upland.

NORTH STRABAN TOWNSHIP

North Straban lies west of Nottingham and has Chartiers Creek for its western boundary. The strata from which its soils are derived begin with the Pittsburg coal vein and extend to the Upper Washington limestone. All the strata, except on Chartiers Creek and in the northern part, that enter the formation of the soil, are above the Waynesburg sandstone, so that this stratum has little or no effect on the soils of the greater part of this township.

Canonsburg, located in the northern part of this township, is surrounded by a very fertile agricultural section, with soils that will endure with judicious handling the intensest kind of farming. The soil in this section is the result of the disintegration of limestone and limy shales and is a clay, except where the sandy strata prevail, there the soil contains some sandstone with the loams. In the vicinity of Wylands and Smithville is another section of fertile soil.

SOUTH STRABAN TOWNSHIP

South Straban township lies south of North Straban and has the National Road for its southern boundary. Washington, the county seat of the county, is situated in this township.

The strata from which the soils of this township are derived begin with the Pittsburg coal bed and extend about 200 feet above the Upper Washington limestone. Along Chartiers Creek the Great Limestone has entered the formation of the soil and produced soils similar to those already described in Chartiers township. The soil in all the northern sections is very fertile and has the same capacity as the soils Chartiers township has. In the vicinity of Washington the soil, though formed of the upper barren coal strata, is fertile and equally as productive as further north. Limestones Nos. 2, 4, and 6 outcrop in the sections south and east of Washington and enter into the formation of the soil. Beside these limestone and limy strata, the remaining formations that enter the structure of the soil are shaly and produce fertile land.

CANTON TOWNSHIP

Canton township lies west of South Straban and Chartiers and has the National Road for its southern boundary. The strata from which its soils are derived range from the Great Limestone which outcrop along Chartiers Creek to the Upper Washington or Limestone No. 6 which occurs in the western, northwestern and central parts of the township. The soil in this township is formed of the strata between the Great and the Washington limestone of the neighboring townships and is very similar. A narrow Divide between Buffalo Creek on the west and Chartiers Creek on the east passes partly through this township on which are some rolling uplands.

HOPEWELL TOWNSHIP

Hopewell township lies west of Canton and Mt. Pleasant, with Cross Creek for its northern and Brush Run for its southern boundary. The strata forming its soils range from a little above the Pittsburg coal bed, which occurs on Cross Creek, to the Upper Washington Limestone, which appears on the Divide between Cross Creek and Brush Run.

Limestone No. 2 has attained a thickness of 15 feet, No. 3, 10 feet, and No. 4 apparently 25 feet, while No. 6 is a remanent on the higher elevations. All these limestone strata enter into the formation of the soils at their respective horizons, as well as distribute their beneficial effects on the formations immediately underlying them and, consequently, on the hillsides of this township can be seen the effects of limestone, limy shale, and sandy formations on the productive capacity of the soils thus formed. The land is hilly and demands hillside farming, but it is all productive. Bluegrass pasture has existed on these hillsides ever since the wood has been cut away, and will continue to exist with only ordinary care. All agricultural crops will thrive here.

BUFFALO TOWNSHIP

Buffalo township lies south of Hopewell and west of Canton, with Brush Run for its northern boundary. In this township, near the Franklin township line and the National Road, the Upper Washington Limestone No. 6 attains a thickness of 25 feet, and is said to make a good agricultural lime. The following analysis of a sample, taken from a vein near Washington, the county seat, gives an idea of its composition:

Vol. K 2nd. Pa. Geo. Survey, Page 388.

Carbonate of lime,	72.866%
Carbonate of magnesia,	3.813%
Oxide of iron and alumina,	2.929%
Sulphur,	.155%
Phosphorus,	.061%
Insoluble residue,	17.380%

About a mile further south another limestone in the same strata crops out and it, like the Washington, enters into the structure of the soil. Limestone No. 2 also outcrops in various parts of this township. In the northwestern corner of this township is a small section of more rolling land. The township is hilly but large acreages can easily be farmed. In the more sandy formation are the apple soils of this township which occur wherever the horizon of the sandstone appears. The strata that form the soils of this township range from the Uniontown coal immediately above the Great Limestone which outcrops in the northwestern section of the township to 80 feet above the Upper Washington limestone which runs along near the National Road close to the Franklin township line.

INDEPENDENCE TOWNSHIP

Independence township lies west of Hopewell on the West Virginia line. The Divide, referred to in Hopewell township, passes through the northern central part of this township and contain some moderately rolling upland, easily farmed and with good productive capacity. Between a branch of Sugar Run and the eastern township line is another such formation. The strata from which these soils are formed range from the Great Limestone, which comes to the surface along Cross Creek in the northern part of the township and Limestone No. 6 or the Upper Washington fragment of which remain on Sugar Creek near the West Virginia line. The soils of this township are so similar to those already discussed that nothing further need be said here.

DONEGAL TOWNSHIP

Donegal township lies south of Independence and west of Buffalo. The strata entering the formation of the soils of this township range from the Waynesburg coal seam to about 75 feet above the Upper Washington limestone. The Waynesburg coal occurs on Buffalo Creek, along the northern part of the township, while the Upper Washington limestone remains on a large number of the hills. Coming in from Taylortown north of Claysville, is a rolling upland formation of good fertility and easily farmed. These upland soils are more rolling and the slopes of the stream are not as steep as in the majority of these townships but not sufficiently moderate not to require great care to prevent washing especially the sandy formations, otherwise this township is very similar to those already discussed in this group.

The southwestern and southern groups of townships having soils largely derived from similar strata, are West Bethlehem, Amwell, Morris, Franklin, East Finley and West Finley, which occupy the southwestern corner of the county.

WEST BETHLEHEM

West Bethlehem lies west of East Bethlehem and south of Somerset, on the Greene county line. The strata from which the soils of this township are derived range from the Waynesburg coal bed, which outcrops about a mile below Pleasant Valley and near Zollarsville, on Ten Mile Creek, in the southeastern part of the township to about 550 feet above this at Hillsborough, on the National Pike. This formation contains the strata of limestones from No. 1 to 6 which vary in thickness and change in composition, sometimes becoming shaly and even limy shales. Whatever their composition may be, their presence is always evident in a more fertile soils wherever their horizon appears. Near Zollarsville Limestone No. 6 is 12 feet thick.

On Little Creek, Limestone No. 2 is 21 feet thick while limestone No. 3 is 5 feet thick, with a coal vein resting on the former, which likely could be used for burning it into lime. Lime will do well in these soils. Amwell township contains the same strata as West Bethlehem. Both these townships are hilly and hillside farming may be necessary here.

NORTH AND SOUTH FRANKLIN TOWNSHIPS

These lie west of Amwell. The outcrop of strata ranges from 100 feet below the Washington coal to 150 feet above the Upper Washington Limestone No. 6.

In North Franklin township, near Washington, and southward from this city, the soil is largely formed of limestone and limy shales and is fertile, adapted to all agricultural crops as well as truck crops.

A limestone formation, or its partly disintegrated remains, occur on the hills and some hillsides of this township and form fertile hilltop soils. The Washington limestone or Limestone No. 6, though in many places at a considerable depth, occurs in many sections of this township as well as South Franklin. The Divide between Chartiers and Ten Mile creeks passes through South Franklin township, upon which is a section of moderately rolling uplands of fertile soils, some of which are formed of limestone and shaly limestone strata. In consequence of the presence of these extensive limestone formations, the sandy soils, derived from the sandstone and sandy shale formations, except these be on the highest outcropping strata, are more fertile than these soils usually are.

MORRIS TOWNSHIP

Morris township lies directly south of South Franklin and west of Amwell. The strata from which the soils are derived range from the Washington coal bed to about 200 feet above the Washington limestone or Limestone No. 6. Limestone No. 7 remains on the surface in the northeastern corner of the township and enters the formation of the soil. Along the hillsides of this eastern section, Limestone No. 6 enters the formation of the soil in a similar way to that already referred to in the discussions of the previous townships. All the limestone formations that enter the structure of the soil of Amwell and South Franklin come into the eastern section of this township.

Along Ten Mile Creek both Limestone No. 3 and No. 4 outcrop, the former at the surface of the stream and the latter along the ridge. Above these, Limestone No. 6 enters the formation of the soil on the hills, and together, with the limy shales, makes a productive section. Bluegrass thrives throughout this entire section and should be allowed to occupy the hillsides.

A Divide between the smaller streams flowing into Ten Mile Creek and Cordys Fork occurs in the western central part of the township, upon which are some splendid upland farming sections.

EAST AND WEST FINLEY TOWNSHIPS

The former lies west of Morris and the latter occupies the southwest corner of this county. The strata from which the soils of East Finley are derived range from Limestone No. 3 to 240 feet above Limestone No. 6, while the strata from which the soils of

West Finley are formed range from the Waynesburg coal vein, which comes to the surface southwest of West Finleyville to the highest strata remaining in this county, very similar to East Finley township. These two townships retain the highest strata remaining in Washington county. The limestone formations and the shaly limestone have decreased in thickness and the sandstone and sandy strata have increased and consequently the soils are less fertile but still sufficiently limy to produce and retain a blue grass sod. The country consequently is more hilly and farming is attended with more labor. Hillside farming should be practiced here to get the best results.

In the northern part of East Finley, on the Divide between the tributaries of Buffalo Creek and Templetons and Robesons Forks, is a rolling upland of fair fertility. It seems that the sandy and shaly soils of these townships should be made the apple soils of this county.

In the western central part of West Finley is another such formation adapted to similar farming operations. All these soils are more fertile than the lower barren measure soils because richer in limestone strata. Grain farming, dairy farming, baby beef, sheep and hog farming should be followed in this county, because by these methods of agriculture the largest amount of human nutrition can be produced and the land improved which is very essential in this section.

GREENE COUNTY

Greene county was erected from the southern portion of Washington county on February 9, 1796. It was named after Nathaniel Greene of Revolutionary fame. It contains 367,360 acres, of which 354,540 acres is land in farms, and of which 306,584 is improved farm land. 24,976 acres were planted in corn in 1909, yielding 982,709 bushels; 14,282 acres were sown in oats, yielding 339,139 bushels; 13,993 acres were sown with wheat, yielding 176,346 bushels; 78 acres were sown with buckwheat, yielding 937 bushels; 294 acres were sown with rye, yielding 3,038 bushels; 1,365 acres were planted with potatoes, yielding 128,697 bushels; 49,850 acres were sown with all forage crops, yielding 49,521 tons of the various kinds of hay. Of the 306,584 acres of improved farm land, 104,838 were used for raising farm crops while 201,746 were not so used and were likely producing weeds. At this time Greene county had a population of 28,882 to feed, 25,775 cattle, 10,316 horses, 114 mules, 19,069 swine and 158,275 sheep.

SOIL FORMATION

Greene county is located in the southwest corner of the State, and is especially noted for preserving the highest known strata of the coal age in Pennsylvania. Its soils are derived from the disintegrated rock of the Monongahela formation, confined to the river section and from the Dunkard formation which covers the remainder of the county; and according to Stevenson's Second Geological Survey of Pennsylvania, Volume K, contains fourteen limestone and limy shale formations.

The county in many sections is very hilly and difficult to farm, but nearly all the soils are productive and some very productive. Bluegrass is the natural grass in this county. Wherever the forest is cut away so that sunlight can penetrate, bluegrass will begin to grow and become the best kind of permanent pasture or after timothy when the timothy has about run its course, the bluegrass will take possession of the soil and form permanent pastures, some of which have not been plowed up within the recollection of the present generation of farmers. The original forest, some of which is still standing was largely white oak and what is most gratifying about it all is that with a little care white oak will come in where it has been cut away.

DUNKARD TOWNSHIP

Dunkard township in the southeast corner of the county is with the exception of the northwest corner well nigh entirely within the Monongahela formation; so are the eastern borders of Monongahela, Cumberland, Greene, Jefferson and Morgan townships. But the slopes of these hills along the river and Dunkard, Whitely, Muddy and Ten Mile creeks are so steep that there has been for ages a continuous washing and creeping down of the soils formed by the disintegrated of the strata of the upper rock that these hill side and alluvial soils of the river bottom are a composition of all that has been brought down by creeping and washing, and by the floods of the river and are not the result of the disintegration of the underlying rocks of the Monongahela formation. The lower levels of these soils and the alluvium are easily farmed and are fertile and adapted to trucking and all kinds of farming and should be more extensively farmed than they now are.

The central and western sections of these townships, except southern Dunkard and Greene, are in the Dunkard formation, and these soils partake much more of the rock represented in this formation, than do the soils of the Monongahela.

*Below Davidstown, in Dunkard township near Meadow Run, is a characteristic formation composed of sandstone and shales twenty feet, Uniontown coal 1 foot, limestone and calcareous shales 23 feet,

*Second Geological Survey of Pennsylvania, Vol. K, page 97.

sandstone and shales sixty feet, limestone and limy shales fifty-three feet, shaly sandstone forty feet, Sewickley coal four feet three inches. The disintegration of such a formation on a hillside will make a soil in which all are represented and in which each will produce its individual effects. The shales and limestone tending to make a fine clay soil and the sandstone tending to make it sandy and more loose and loamy. All these and more of the influences of these rocks can easily be discovered upon examination of the soils.

Another characteristic formation is found at the Bowlsby coal opening near the State line where are exposed forty feet of sandstone, five feet of drab shale, three feet of dark shale and seven feet nine inches of coal and clays, this makes a fine loamy soil but not as productive as the formation above referred to as any one who investigates the formation can easily see.

Further north in Greene township in the Dunkard formation on the hillsides are found fragments of Limestone No. 5 and 6 showing that these have taken part in the formation of the soil here and also at the run which flows into Whitely Creek. At Girards Ford, Limestone No. 1 is exposed.

JEFFERSON TOWNSHIP

Jefferson township is the northeastern township of Greene county, fronting on the Monongahela River. Its geological formations begin with the Pittsburg coal vein and extend up to Limestone No. 10. The following formations are exposed near Dowlings Schoolhouse, on the run about one and a half miles south of Jefferson: Limestone No. 10, five feet, shale and sandstone, seventy feet, Limestone No. 8, 2.6 feet, coal blossom shale, thirty feet, limestone 7.3 feet, coal blossom shale 40 feet, coal limestone No. 6, five feet, shale thirty feet, Limestone No. 5, four feet, concealed 220 feet, Washington coal bed four feet. These are the rock formations from which the soils of this section are derived in the vicinity of Jefferson, especially the valley in which the town is located. These have produced an elegant agricultural soil, fitted for market gardening or any other kind of farming. On the hilltops, in the vicinity of this town, the limestone clays exist and still contain a sufficient quantity of carbonate of lime and likely other carbonates to reveal their presence by chemical tests.

CUMBERLAND TOWNSHIP

Cumberland township lies directly north of Greene and Monongahela. The rock formations from which the soils are derived, except those along the terraces of the river and Muddy Creek, which flows across the township from west to east and the alluvials along these streams, range from the Sewickley coal bed at Little Whitely Creek,

to Limestone No. 5. This township, therefore, has limestone strata which enter in part into the formation of its soil, aggregating some thing like 85 feet and which are accessible for use as lime upon these soils.

At Carmichaels, in the eastern section of the township, on the upper barren coal measures, is a beautiful rolling country especially adapted for farming, though splendid pasture lands abound which can and should be farmed. This formation extends on the Divide between Muddy and White creeks into Greene township, south of Rices Landing, along the road to Jefferson. Above the river hills the land is fertile and not too hilly to farm. Several limestone formations outcrop along this road. Here are typical farming sections of the eastern part of the county of the best kind of farming soils.

Perry, Whitely, Franklin and Washington townships follow each other from south to north and are entirely in the Dunkard formation, with the exception of a narrow belt along Ten Mile Creek northeast from Waynesburg.

PERRY TOWNSHIP

Dunkard Creek flows through Perry township from west to east and for some distance about Mt. Morris forms one of the most fertile valleys of the county, though having steep hillsides, yet with care these soils can be farmed and the best crops with little expenditure for fertility but with thorough cultivation, obtained. This was done years ago and can be as well done now. The western section of this township is hilly and the hills are more steep and less rolling than further east, likely because that this southern and southwestern section has fewer limestone and shaly strata and more sandstone, than the formations further east.

WHITELY TOWNSHIP

The formations in this township likely range from the Washington coal bed along Whitely Creek, to Limestone No. 6 in the western end of the township. These strata outcrop in the sections referred to but that the formations are confined within these limits is not certain, but that it is approximately correct, is fairly certain because nearly all of the soils of this township are derived from shales and sandstones which outcrop in many sections. These soils are largely loams, sometimes stony but usually not, and are easily farmed. The eastern, southeastern and southwestern slopes are usually more fertile than the northern and western exposures. Bluegrass and the pasture grasses thrive here showing that though these soils derived largely from disintegrated shales and sandstones, contain sufficient lime to produce bluegrass. Wherever the bluegrass is driven out by weeds, if lime is applied the bluegrass will drive out

the weeds. Apples and peaches do well here and fruit raising should be made one of the specialties. In the vicinity of Mt. Pleasant Church the limestone outcrops in the valleys and can be quarried and burned into lime for agricultural purposes, for which it seems to be sufficiently pure. This is one of the best agricultural sections of the township.

FRANKLIN TOWNSHIP

Franklin township lies north and west of Whitely. Waynesburg, the county seat, is located in this township. Ten Mile Creek flows across it from west to east. The rock strata from which the soils of the township are derived range from 150 feet below the Waynesburg coal to 250 feet above Limestone No. 8. The soils of the township, therefore, contain the lime and sandstone and shaly rock strata lying between these extremities.

In the eastern part of the township the Waynesburg coal is mined where, about 40 feet of the Waynesburg sandstone overlays the coal and enters into the formation of the soils in this as well as a number of places as far west as Waynesburg, from whence it derives its name when it passes out of sight. In the vicinity of Waynesburg, especially east of the town, Limestone No. 3 is exposed and has been quarried and lime burned for agricultural purposes. The vein is about three feet thick. Above and below this limestone formation are limy shales, limestone and sandstone which enter into the formation of the soil. Further west and southwest Limestone No. 4, 5, and 6 come into the formation, No. 4 which, is found in fragments on the hillsides about the town, the effects of which are evident in the soils. West of Waynesburg on the hill, Limestone No. 5 outcrops and enters into the formation of the soils and produces its usual salient effects, while still further west near Browns Fork No. 6 and 7 are exposed. The limy formation lying about the surface here are supposed to belong to limestone No. 8. The hills on the eastern part of this township are not as steep, are more rounded and do not wash as readily. The disintegration of these rocks has proceeded to a considerable depth here as it also has in the township before discussed and, therefore, the soils can be made as deep as any one may desire, which if made deep and would then be filled with organic matter, there would be little or no washing.

MORGAN TOWNSHIP

Morgan township joins Washington county in the north and Ten Mile creek forms the boundary between it and Jefferson township on the south. The exposed rock strata from which its soils are derived extend from the Sewickley coal in the upper coal measures to Limestone No. 10 in the upper barren rocks.

This is one of the most fertile agricultural townships of this county. Beginning in the eastern part of the township with the junction of Ten Mile and North Fork creeks and following these streams to the northern and southern corners of the township and from here westward, all the formations referred to will be crosses. In a section in the northern part of the township a thickness of twenty feet of limestone and limy shales are exposed. These are largely made up of the great limestone which here is divided into four sections. From this westward to the township line the various limestone of the numbers between the Great Limestone and No. 10 which remains near the western limits of the township appear here and there. These exposures make limestone accessible in all sections of the township as well as a factor together with the shales and sandstones in the formation of the soils of the township.

WAYNE, GILMORE AND SPRINGHILL TOWNSHIPS.

Wayne lies directly west of Perry township. The strata of rock from which the soils of this township have been derived are entirely in the upper barren measures, ranging from the Washington coal to Limestone No. 5, above which no strata can be recognized. This township is hilly and the soils are more sandy than the townships previously discussed, except where the limy shales and the limestone enter the soils of which there are not many instances. The uplands of this township will produce bluegrass and furnish pasture for sheep. A considerable acreage of the land farmed and produces well especially the hay crops, corn, wheat, oats, rye and more especially apples, potatoes do very well here.

Gilmore township lies directly west of Wayne. The strata of this township are, geologically, the highest in the State, ranging from the Jollytown coal bed in the southeast to the highest known rock in the northwest. The hillsides of this township along the streams are steep but some of the uplands can be and are being farmed but like Wayne, this township should be engaged in stock raising especially sheep. The high dividing sandstone ridge between Dunkard and Fish creeks, in the western part, rise in sharp hills in all directions making farming impossible.

Springhill township occupies the southwestern corner of the State and is even more rugged than Gilmore. The valleys of the streams are narrow and the hills inclosing these are steep and abrupt, so that all farming land is confined to the hills and here on many of the dividing ridges a sandstone covers the surface making farming operations impossible. Where shales and sandstones mingle in the formation of the soils, apples do well and corn, oats, hay and bluegrass thrive and pasturing can be successfully followed and should be made the main source of income for the farmer.

ALEPPO TOWNSHIP

Aleppo township lies directly north of Springhill. The rock strata from which the soils are derived extend from the top of the upper barren series remaining here, to below the upper Washington limestone and, therefore, about all the barren rocks are included in the soils. The highest of these occur only in the southern portion of the township on the Divide between Fish Creek and South Wheeling, while the limestone formation comes up near the township line in the north. A limestone vein occurs on this township cropping along the little streams between Limestone No. 9 and 10, which is sort of shaly and while likely impure, wherever it enters into the formation of the soil, the effects are very evident.

The great sandstone referred to in Gilmore and Springhill townships also occurs here in the ridges and enters into the formation of the soil and produce their characteristic effects. This township has a larger number of the strata of the upper barren rocks, entering into the composition of its soil than any of the townships this far discussed. The land is hilly but will produce well, all agricultural crops but is better adapted to stock raising.

Jackson township lies east of Aleppo and west of Center. The rock strata entering the formation of its soils range from the highest of the barren strata to Limestone No. 9. Limestone occurs on the hills in the vicinity of White Cottage and enters into the formation of the soil though impure makes soil more productive. The great sandstone also occurs here and rises above the limestone and enters into the formation of the soil producing a sandy soil. Northwestward from this place near the Richhill township line, two limestone formations occur which show their good effects. Southwestward, the highest shaly and sandy strata cover the surface making soils which are not so fertile.

CENTER TOWNSHIP

Center township lies east of Jackson and west of Franklin. The rock strata from which the soils are derived extend from the Jollytown coal bed to the top of the barren rock as these occur in this township. These strata include Limestone No. 5, 6, 7, 8 and 10, all of which enter into the formation of the soils in the various sections of the township and like the townships paralleling it east and west, its soils are more productive than the soils with only the higher barren strata and fewer of the lower limestone formations. At Rogersville, along Ten Mile Creek, especially between Rogersville and where Pursely Creek enters Ten Mile Creek, all these limestone strata are exposed. From this place south to Oak Forest, Limestone No. 5, the lowest of the limestone strata of the barren series

exposed in this township, is about 120 feet above Pursely Run while at the mouth of the creek it is only about 60 feet. This same thing occurs with the remaining limestone strata higher up in this upper barren formation so that limestone occurs in many sections of the township and together with the sands and shales produces soils more fertile though quite as hilly as elsewhere in the country.

MORRIS TOWNSHIP

Morris township lies directly north of Center on the Washington county line. The rock strata from which the soils of the township are derived extend from Limestone No. 5 to the top of the upper barren formation. In the southeastern corner of the township, limestone outcrops along the creek and limestone is scattered about the fields on the hillsides. At Nineveh, near the central part of the township, a limestone occurs, together with sand and shales, forming a soil that is fertile and productive. From this place northward, shaly limestone and sandstones form the soils, all of which produce well.

WASHINGTON TOWNSHIP

Washington township lies west of Morgan and north of Franklin. The strata of rock from which its soils are derived extend from Limestone No. 3 to No. 10 of the upper barren formation. Near the southeastern corner of the township, the limestone outcrops from this place northward and westward, the lime and sandstone of the various strata between No. 3 and No. 10 form the soil, of which the more limy are fertile and the sandy of which there are few, not so fertile but productive.

RICHHILL TOWNSHIP

Richhill township lies in the northwestern corner of the county. The rock strata which enter into the formation of the soils of this township begin with the Waynesburg coal bed in the upper productive coal formation and extend to the top of the barren measures, likely a greater depth of strata than enter into the soils of any township of the county. The highest of those strata occur along the southern section of the township while the lowest occur along Wheeling Creek, near the West Virginia line, and along the northern border of the township on the Washington county line, on Hunters Fork of Wheeling Creek. The soils of this township are fertile and productive except in such places as in the southern part where on the ridges the sandstones already referred to largely form the soils. The more rolling formation of the central and northern sections have soils that produce as well as those of the townships of the eastern part of the county.